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June 30, 1975

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APPENDIX I

of

FINAL REPORT

AMPS DATA MANAGEMENT REQUIREMENTS STUDY

Prepared for

GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama

Contract No. NAS8-31208

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TABLE OF CONTENTS

1.0 INTRODUCTION

All the flow charts and display formats for the simulation of the following five experiments are given in this appendix:

1. Electromagnetic Wave Transmission Experiment
2. Passive Observations of Ambient Plasma
3. Ionospheric Measurements with Subsatellite
4. Electron Accelerator Beam Measurements
5. Lidar Trace of Acoustical Gravity Waves in the Sodium Layer

A detailed explanation of the simulation procedure, definition of variables, and an explanation of how the experimenter makes display choices is also presented. A functional description is included on each flow chart and the assumptions and definitions of terms and scope of the flow charts and displays are presented in the following sections.

Part 3.0 of the AMPS DMRS Final Report contains the theory and summary description of each experiment. All the equations required for the simulation of each experiment along with the required angular transformation for boom control simulation and the equations for the simulation of associated instrument displays are also given. The capability to control and display the associated instrument outputs is described and the special purpose equipment needed to perform these functions is listed.

2.0 GENERAL ASSUMPTIONS

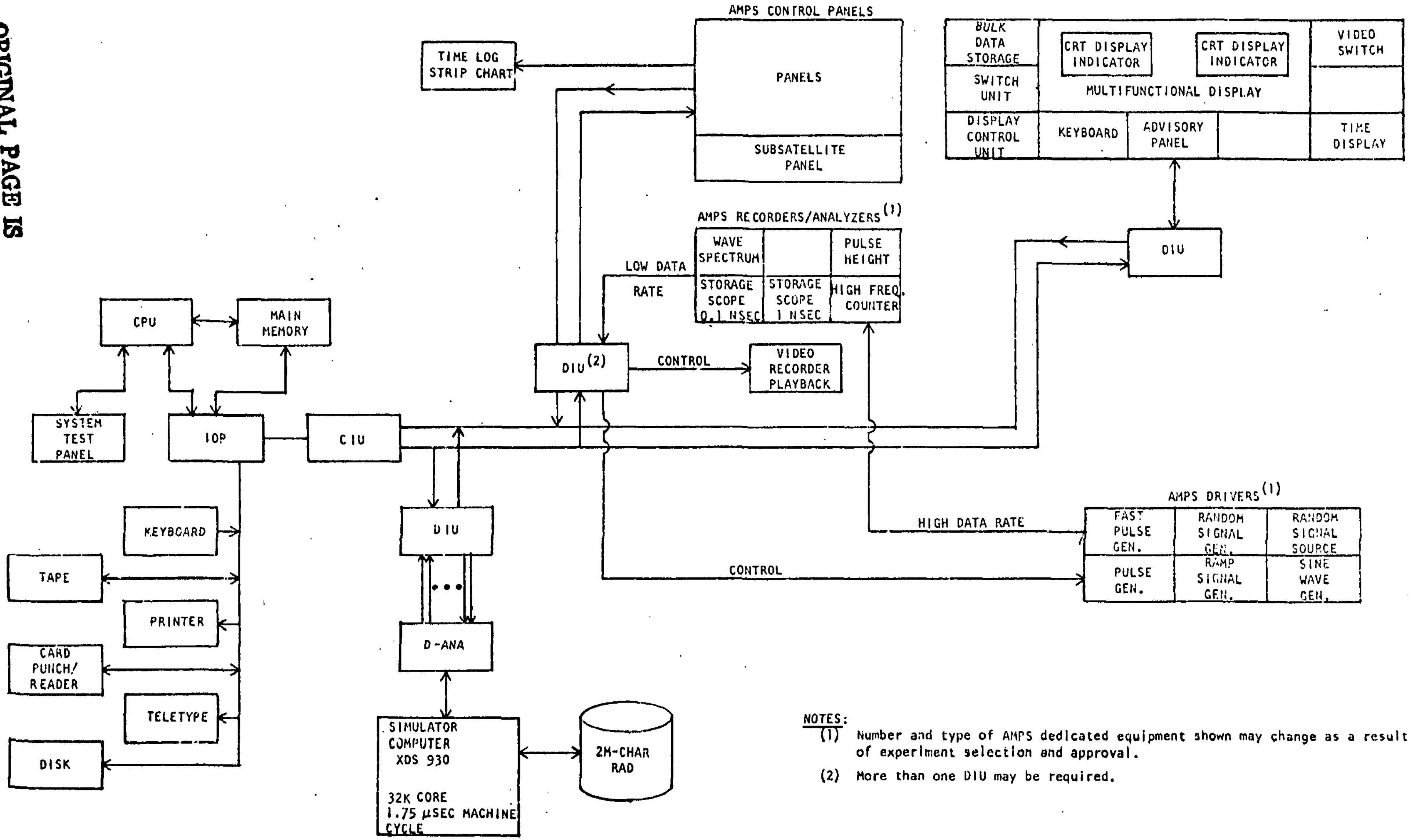
The following general assumptions have been made in approaching the construction of these flowcharts and the associated display layouts.

2.1 HARDWARE SYSTEM

The system on which the flowcharts will be implemented is as diagrammed in Figure 2.1.1. The flowcharts are functional and do not necessarily include or exclude the use of the XDS 930 computer.

2.2 FLOWCHARTING STANDARDS

Flowcharting standards are as specified in MSFC computer program documentation standards, Part 5.3 of the MSFC Programmer Procedures Manual, dated



NOTES:
(1) Number and type of AMPS dedicated equipment shown may change as a result of experiment selection and approval.
(2) More than one DIU may be required.

FIGURE 2.1.1

November 1972. A top-down structured programming approach has been maintained in addition to the above standards.

2.3 EXPERIMENTER FLEXIBILITY

The experimenter shall be able to start, stop, enter, change and delete instrument or boom settings in any order without restriction, except where equipment damage would result and safeguards are practical.

2.4 EXPERIMENTER TRAINING

Experimenter training needed to run a CVT experiment should be minimized by making CVT simulation operation self-explanatory to a maximum practicable extent.

2.5 FLEXIBILITY TO ACCOMMODATE CHANGES

The flowcharts and displays need provisions to accommodate new display options and new data processing routines, insofar as practicable.

2.6 DISPLAY STANDARDS

Display standards shall be as specified in "CVT Spacelab Simulator and C&D Subsystem Performance and Design Requirements Specification", 40M35719, MSFC, dated May 28, 1974.

3.0 FUNCTIONAL DESCRIPTION

Functional descriptions are included on each flowchart. To prevent needless repetition, the following description describes elements that are common to all or at least several flowcharts and displays.

3.1 HIERARCHICAL ORGANIZATION OF SOFTWARE

The flowcharts and displays are organized in a hierarchy with one root at the top and the branches extending downward. The points where branches are joined together are called nodes. These are places where the experimenter can choose the branch (the part of the experiment) that he wishes to be doing. Additional branches can be grafted on, or pruned from, each node should this become necessary or desirable.

The root of the tree for all AMPS experiments is "Plasma Physics". At this root (node) the experimenter can choose which experiment he wishes to perform. The root of the current set of flowcharts is an individual experiment, which assumes that the experimenter has already decided to choose this experiment at the Plasma Physics node. The second level is the setup of the individual booms, platforms and instruments, considered as individual building blocks.

Where convenient to the experimenter, this second level may also contain special-purpose combinations of instruments that interact in a special way to serve the experiment.

The third level contains the processing needed to process the logic and data of the instruments or special-purpose combinations.

Logically, there can be defined as many nodes and branches and their levels as the experiment requires.

3.2 DISPLAY HIERARCHY

All major experiment choices are at the discretion of the experimenter and therefore involve a display. This display presents to him the choices that are open at that particular node including his choices of moving from one node to the next. If the experimenter chooses to move from one node to the next, the current display will disappear from his MFDS CRT, and the display appropriate to the next node chosen will be displayed instead. Thus the displays form a display tree that parallels the major nodes in the software.

Each experiment is introduced by a set of flowcharts numbered from 10 to 14 that show the breakdown of the experiment into its basic operations. A display tree is provided that can serve as a roadmap to the experimenter's display interfaces with the experiment. (See Figures 3.2-1, 3.2-2, 3.2-3, 3.2-4, 3.2-5.)

3.3 EXPERIMENTER DISPLAY CHOICES

The following discussion outlines a specific method by which the experimenter will exercise his choices. This method is fundamental to the operation of the experiments to be flowcharted, HOWEVER, THE SPECIFIC

SYMBOLS USED IN WHAT FOLLOWS DO NOT CONSTITUTE A COMPUTER LANGUAGE CHOICE BY TRW. These symbols are used merely for convenience in flowcharting and exposition only and should be interpreted as such.

The following is the meaning of the symbols used on the flowcharts and display formats. The general form of each experimenter entry is: XX:Value. Each part of this entry is described below:

XX	:	VALUE
The "Entry Number", an integer from zero to 99, listed on the left hand margin of the display.	A symbol used as separation between Entry No. and Entry Value.	The "Entry Value", the logical (YES, NO, etc.) or numerical value of the entry made by the experimenter.

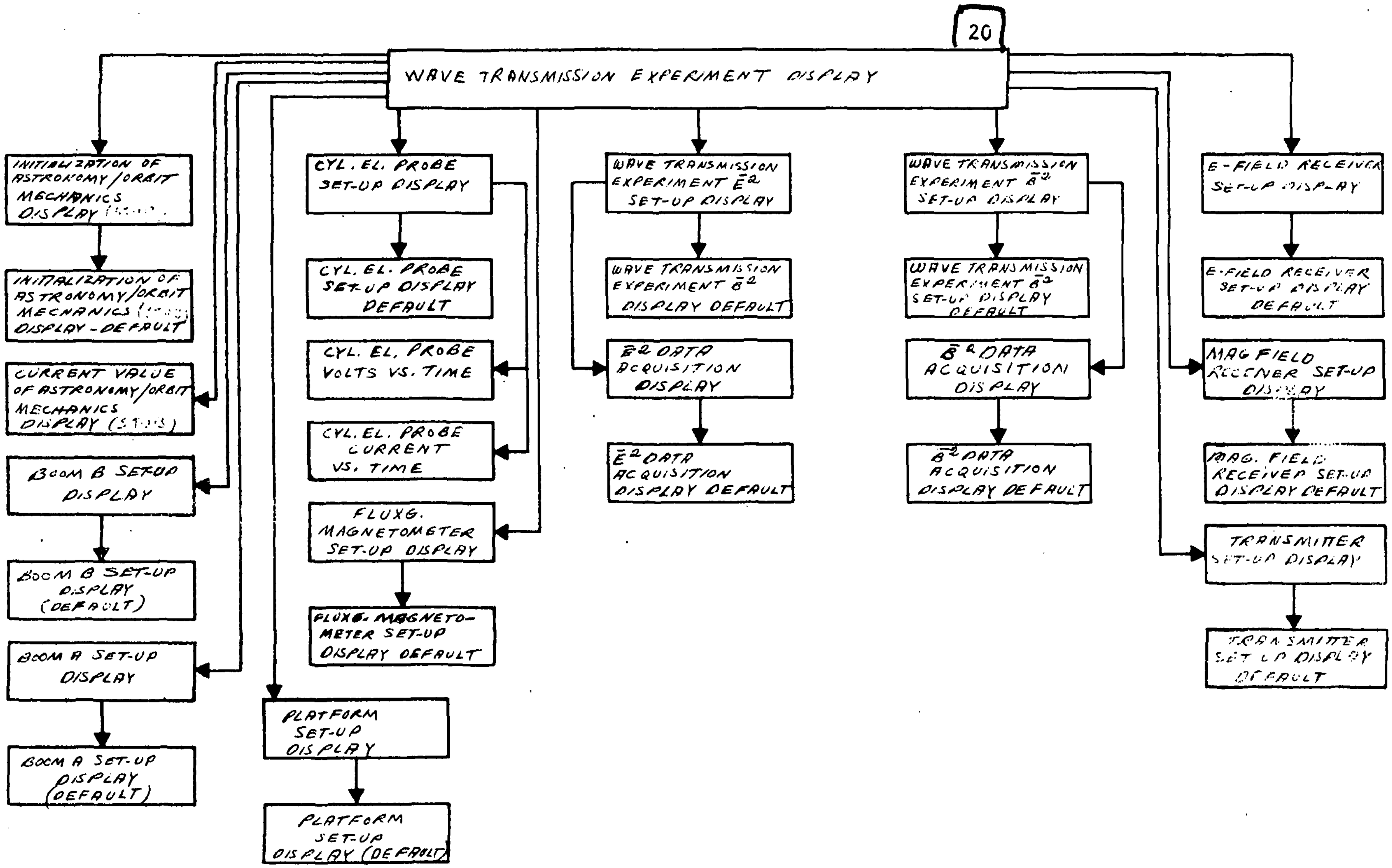
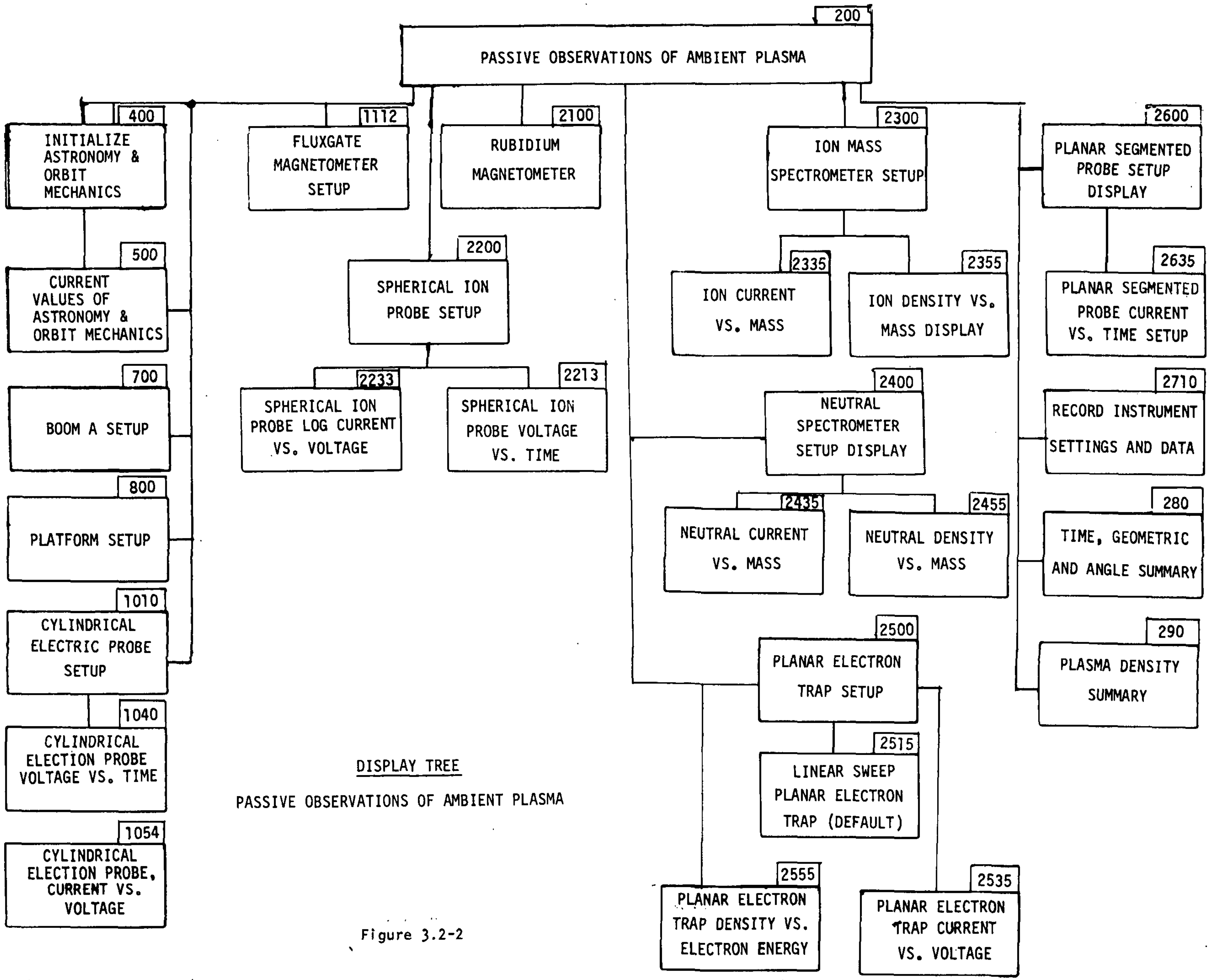


FIGURE 3.2-1 DISPLAY TREE



DISPLAY TREE

PASSIVE OBSERVATIONS OF AMBIENT PLASMA

Figure 3.2-2

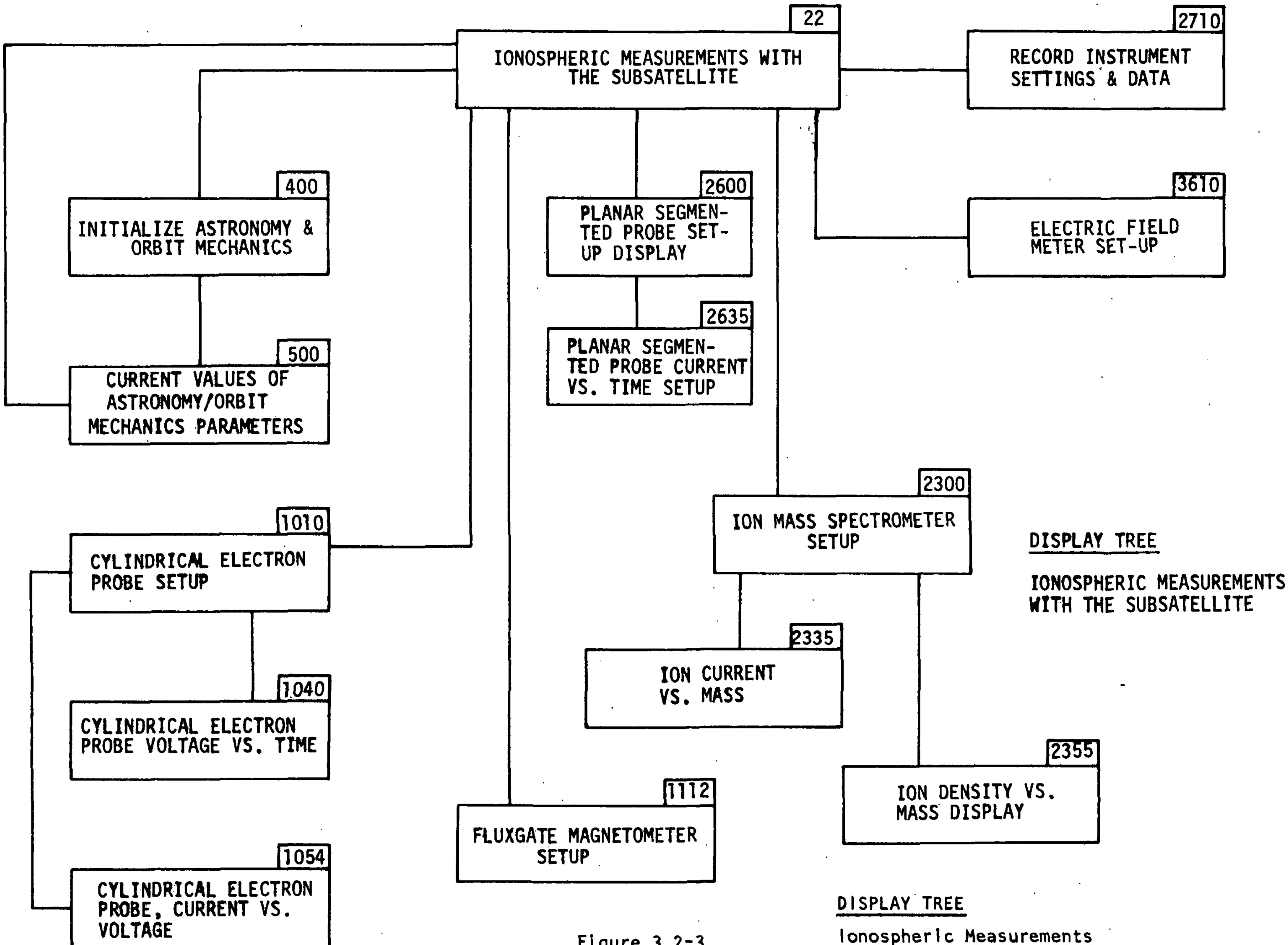
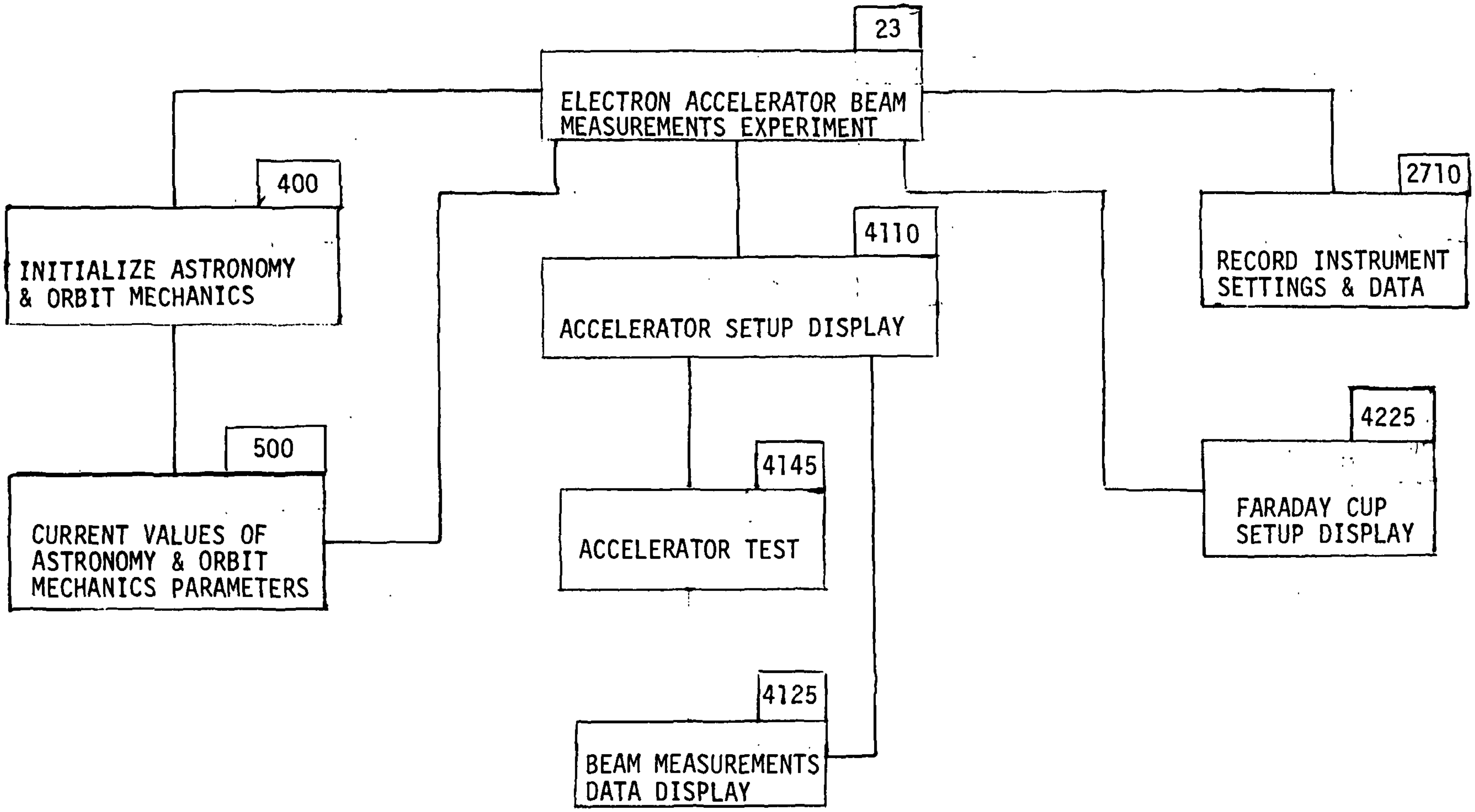


Figure 3.2-3

DISPLAY TREE

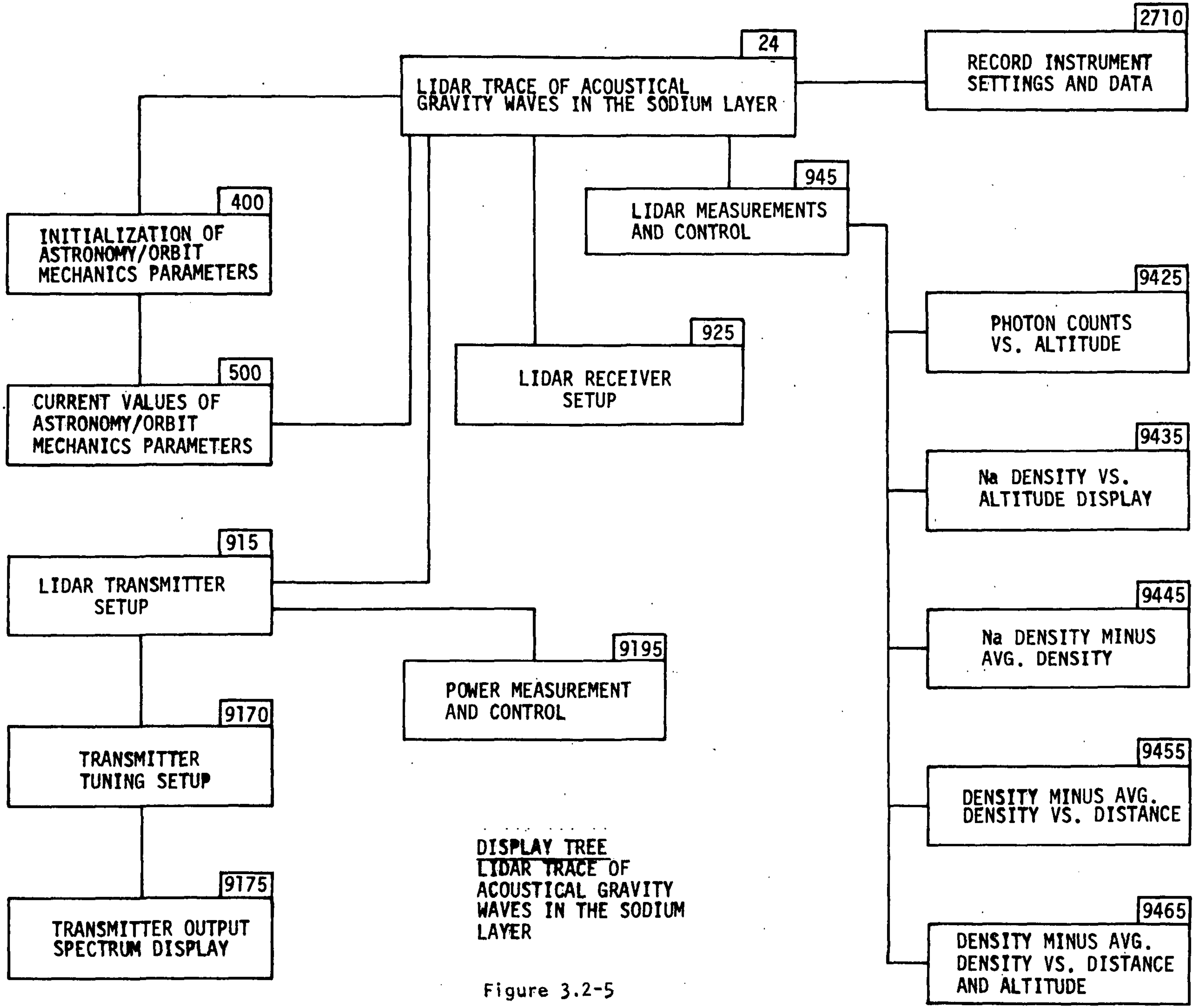
Ionospheric Measurements with the Subsatellite



DISPLAY TREE

ELECTRON ACCELERATOR
BEAM MEASUREMENTS
EXPERIMENT

Figure 3.2-4



DISPLAY TREE
LIDAR TRACE OF ACOUSTICAL GRAVITY WAVES IN THE SODIUM LAYER

Figure 3.2-5

3.3.1 Example

A specific example will be used to illustrate the operation of the system. In the Wave Transmission Experiment, Display No. 20, the experimenter has 15 choices. Let us assume he wishes to turn the Wave Transmission (W.T.) Instruments ON. He will key in the following symbols on the keyboard:

1:ON

The word ON will appear in the glank provided on line 1: of the display. This entry on the keyboard will turn on and warm up the electronics and controls of all instruments necessary for performance of the Wave Transmission Experiment. After all instruments are warmed up, READY will appear in the box immediately below entry line 1:. If the experimenter wishes to turn the instruments off he will enter:

1:OFF

which will turn the instruments off and cause READY to disappear.

If the experimenter wishes to set up Boom B into position, he will enter:

5:I.

This will cause Display 20 to be replaced by Display 600, from where the experimenter can proceed to specify the particular Boom B position he wants.

3.3.2 Meaning of Entry Values used by Experimenter

There are five entry values that are widely used by the experimenter:

- UP -- This entry value will return the experiment to the next higher node on the tree, and show the display appropriate to that node.
- I -- This entry value will take the experiment down to the next lower node on the tree, along the branch indicated by the specific entry number. Where a specific numerical value choice or logical choice is available on a display, the choice of I instead will cause the default values for that choice to be displayed.
- D -- This entry value will delete all previous experimenter entries for the nodes below the node in which the experimenter currently finds himself. If D is entered for the entire Wave Transmission Experiment (0:D on Display 20) this destroys all previous experimenter entries.

- SPARE -- This is a location on the display where the programmer can insert a new option. This is simplist to accomplish if the new option is based on subroutines or instrument models already available in the existing library. If not, the subroutines supporting the new option must be designed, coded and integrated into the software system.

- I/NO -- These entry values have a fairly complex meaning. If :I is chosen, from this combination of values computer program will show the display appropriate to that choice, and assume that the experimenter values or default values appropriate to that branch are to be chosen in computing subsequent portions of the experiment. :NO chosen from the I/NO combination reminds the experimenter (later in the performance of the experiment) that he did not wish to use this branch or its default. An error message will appear if the experimenter fails to enter a useable alternative choice for the prohibited :NO branch.

If the meaning of the choices available to the experimenter is not obvious to him he can refresh his memory as to their meaning by entering 0:I on his display. This will cause to appear on his CRT display either an instructional display or a page number reference to his instruction manual, containing definition of instrument settings or other items he might need. TRW is not necessarily suggesting that complete instructional text be a part of the CVT computerized system.

The need for this is not clear. The practicality of this will depend on the size, cost and convenience of mass storage use.

3.3.3 Values Displayed to the Experimenter by the Computer

All constants and logical program entries are under the control of the experimenter. However, some quantities are computed by the computer based on these entries and are thus only indirectly under experimenter control. Quantities computed by the computer that are in this sense indirectly under experimenter control are enclosed in rectangular boxes on the display. An example is actual Boom A position length and angles (Display No. 700).

3.3.4 Values Jointly Under the Control of the Experimenter and Computer

It is clear that setting up an experiment may involve making numerous adjustments to several instruments. The flowcharts assume the following protocol to assist the experimenter in keeping track of where he is in setting up his experiments (See Flowchart No. 21).

1. If he enters a D entry value the experimenter's entries at lower levels will be destroyed and their display will show a "?" (question mark). If the experimenter enters 0:D all experimenter entries on the display he is looking at and the subordinate modes will be so destroyed. Default values, however, will not be destroyed by this procedure.

2. If the experimenter fails to enter any choice where a question is displayed, the computer will assume default values for this choice.

3. The entire set of experimenter entries can be destroyed by entering 0:D on Display 20. The experiment can then proceed to the maximum extent based on default values.

4. Whenever the experimenter makes a choice of an entry value, this value is displayed to him on the display where it is made, and remains there until replaced by a question mark. Thus the experimenter can determine by looking at his display, what part of the instrument (non-default) settings he has made.

5. The experimenter may choose to delete a specific entry he made. He does this by entering a "?" in the appropriate location. This entry specifically changes only the value previously entered.

4.0 DISPLAY FORMATS

As in common industrial practice, display formats are here specified in terms of how the display would actually look to the user. The display area shown on each of the suggested displays has been printed on millimeter paper for ease in interpreting the display in terms of X, Y cathode ray tube coordinates. The area used is approximately equal to the undistorted part of the MFDS cathode ray tubes.

5.0 OPERATING SYSTEM INTERFACES

This section describes the capabilities, at a functional level, that the experiments flowcharted will require of the computer operating system. No distinction is made, in what follows between the SUMC and the XDS 930. Either the SUMC above, or the SUMC plus the XDS 930 can be used. If both computers are used, an important computer-to-computer communication function is added to the functions performed by the system. However, in what follows continual reference will not be made to the alternatives raised by these two system configurations.

5.1 EXPERIMENT SIMULATION SUPPORT

Each of the five experiments will be run on a separate (non-concurrent) basis.

5.2 PERIPHERAL USAGE, I/O SUPPORT

It is believed that the SUMC computer or the SUMC/XDS 930 combination can contain in core all the programs specified herein for any one experiment, including the required data and working storage areas and the required operating system(s). Peripheral support is required for loading, assembly, compilation, diagnostic and other maintenance functions but probably not required during simulation of the experiments themselves—with two potential exceptions:

5.2.1

If the (now stubbed) magnetic tape recording of experiment data is implemented—this obviously requires the tape recorder itself as a peripheral.

5.2.2

If there is added a printout or other log of the experimenter's activities for post-simulation analysis of how quickly or how well the experiment was performed.

Obviously, if the scope of the experiment simulation is expanded, or extremely inefficient operations are called for, additional peripheral support may be required.

5.3 MEMORY MANGEMENT SUPPORT

Each experiment consists of individual (building block) tasks. The experimenter has the following options that memory management must support.

5.3.1

During simulation runs, the experimenter may activate various preplanned instruments and displays in sequences and at times of his own choosing.

5.3.2

Between simulation runs, the experimenter may decide to add an additional instrument to the list participating in the previous simulation run, and this may lead to a requirement for additional physical models to support this requirement.

5.3.3

Between simulation runs, the experimenter may decide to change scales on his display, leading (perhaps) to increased size in data regions supporting this display.

5.3.4

Data may be either specific to a single functional area or may be accessed/changed by more than one functional area.

5.3.5

In spite of 5.3.1, 5.3.2, 5.3.3 and 5.3.4 above, the amount of data used and produced by each task within an experiment should be quite accurately predictable.

5.3.6

The plasma physics experiments do not require extreme accuracy. It is believed that all data can adequately be represented by single-precision numbers. For experimental data, floating point representation may be preferable, because of the possibility that large changes in the magnitude of the numbers will be required as the experiment is refined.

5.4 EXPERIMENTER COMMUNICATIONS

All experimenter communications entering the computer via these flowcharts are initiated via the MFDS console keyboard. Some equipment settings (e.g., in the Wave Transmission Experiment) are also initiated from this keyboard. Almost all displays are via the MFDS experimenter CRT. Rapid response of the computer system (e.g., within 4 seconds), to a keyboard command is psychologically desirable but not required for the success of the experiments flowcharted.

5.5 TIMING AND SEQUENCING SUPPORT

This is the area of greatest potential complexity in interfacing with the operating system, because of the multiplicity of demands that may arise. The application programs will need the following types of support:

5.5.1

Tasks that need to be recomputed on a periodic basis (e.g., the current values of astronomy/orbit mechanics quantities need to be recomputed every 2 seconds).

5.5.2

Tasks that need to be recomputed on a periodic basis until a specific end-condition is reached (e.g., boom positioning, platform positioning), and stop thereafter.

5.5.3

Tasks that compute future availability of an experiment resource (e.g., simulate warmup or settling time of a piece of equipment) on a one-time basis.

5.5.4

Tasks that need to be recomputed on a pre-specified basis (e.g., using a display specification to determine when to recompute the data points to be displayed on a two-axis (XY) graphical CRT display, with one of the axes being a time axis).

5.5.5

Tasks that need to be computed only once, as in setting a gain constant in an instrument computation.

5.5.6

Tasks that have been requested, but where no specific need-to-see time is specified (e.g., display of a simulated instrument calibration curve).

5.5.7

Tasks that simulate high-data rate acquisition from a sensor source, but where the processing of this data for display must proceed at a slower rate. This will probably involve buffer allocation and use.

5.5.8

Tasks that have been interrupted and need completion.

5.5.9

Tasks that have not been executed within the timing cycle allocated because of their low priority, but which need to be executed at a later time (possibly involving priority level manipulations).

5.5.10

All tasks need to have the support of a time-out routine. Since the experimenter has the power to alter the constants and the instruments that participate in an experiment, unforeseen situations may arise which can bring the system to a halt. Provision of time-outs will permit the system to continue to simulate the experiment even though some deficiency may temporarily exist.

6.0 FLOWCHARTS AND DISPLAY FORMATS

The flowchart and display format data is presented in three sections. The first two sections define the variables and specify the range of values for specific sets of variables. The flowcharts and display formats are presented in the third section. Each flowchart includes a functional description and is associated with a specific display format simulating the display of the MFDS CRT.

The procedure, sequencing and parametric definition of default values has been carried out in great detail for the Wave Transmission Experiment in order to present an illustrative sample of how the flowcharts can be used. There are, of course, a large number of other options available in the sequencing of the Wave Transmission Experiment, and the four subsequent experiments. Similarily, the selection of typical default values was included

in the Wave Transmission Experiment only in order to strengthen the concept of the experiment flowcharted—particularly the orientation of the orbiter and spacecraft while the measurements are being taken. In general, we believe that the selection of the default values should be left to the experimenter.

6.1 WAVE TRANSMISSION EXPERIMENT

(The experiment procedure for this experiment is given in Section 3.1.2 of the Final Report.)

The key to the understanding of the Wave Transmission Experiment flowchart and displays in Display No. 20. The effect of making entries under Entry Numbers 0: and 1: have already been discussed in Sections 3.3.1 and 3.3.2.

A fixed and unvarying equatorial orbit is assumed for this experiment as orbital variations do not impact the essential concepts of this simulation (Entry No's. 3: and 4:), Astronomy/Orbit Mechanics computations are stubbed for this experiment.

Entries No's. 5: through 12: permit the experimenter to set up his individual experimental instruments. He can do this in any order he pleases, (although he would be wise to set up Boom A before setting up the platform).

Finally, Entry No's. 13: and 14: permit him to investigate the electric and magnetic plasma fields independently and sequentially.

Both a manual and an automatic method of stepping through the range of frequencies of interest is provided as explained below. The choice between these two methods is on Displays 1510 Entry Value 12: for the electric, and on 1616 Entry Value 12: for the magnetic field measurements. If the experimenter does nothing, the automatic sequence will be chosen (see Displays 1511 and 1611).

The Wave Transmission Experiment illustrates graphically the tradeoffs involved in maintaining the <u>instrument-by-instrument</u> building block concept, as against inventing a special purpose <u>experiment</u> concept where the setting of two or more sets of instruments are effected using a single computer-driven display.

For example, Display 1610 gives the opportunity to set both the transmitter center frequency and the receiver frequency band for the magnetic field transmission experiment. By the building block concept, these same settings can be accomplished for the transmitter via Display 1410 and for the receiver in Display 1310. Care must be taken in the software implementation to assure that the convenience to the operator given by 1610 (not having to switch between 1310 and 1410 for every manually controlled experimental frequency setting) is not overbalanced by the time spent implementing and checking out the additional software involved, which is primarily display software.

6.1.1 Performance of the Wave Transmission Experiment

Below is an example of a typical sequence in performing the Wave Transmission Experiment. This typical sequence is included for illustartive purposes only and is not repeated for each experiment.

The job of setting up the instruments and running the experiment can be performed by the experimenter in any sequence that he pleases. It is expected that the experimenter will normally avail himself of the convenience of the automatic frequency sequencing provided. This sequencing automatically adjusts the frequency of both the transmitter and receiver to step through a sequence of frequencies covering the frequency neighborhood that is close to the plasma frequency being investigated here. The experimenter will then go through the following steps (assuming that he does not wish to deviate from the default values provided). Starting with Display No. 20

1. Experimenter enters 0:D on Display 20. This will remove all previous entries, and secure the use of default values for boom, platform and instrument settings. 1:ON turns all instruments ON.

2. Experimenter enters 13:I, this will give him Display 1560 which applies to measuring the mean square electric field $\overline{E^2}$.

3. The experimenter notes whether the instruments are ready.

4. The experimenter notes the noise level on his special-purpose receiver display.

5. The experimenter turns the transmitter on (5:GO) on 1560.

6. The experimenter adjusts the transmitter attenuator, (4:) on 1560, until the received signal level is 100 times the previously observed noise level (Step 4).

7. If Display 1560 shows a satisfactory $\overline{E}^2$ level, the experimenter may wish to record this data and associated instrument settings (6:GO). This will record instrument settings (once) and the $\overline{E}^2$ data and time for as long as the recorder is on (once per second, for example).

8. When the experimenter believes he has recorded a sufficient amount of $\overline{E}^2$ data he will stop the recorder (6:STOP).

9. The experimenter will now go to the next frequency by entering (2:YES).

10. The experimenter will now stop the transmission by the transmitter (5:STOP). He is now ready to repeat Steps 4 through 10 above for the next frequency on the automatic frequency list.

11. The experimenter repeats Steps 4 through 10 until he has enough data.

    The same sequence as above applies to the measurement of the mean square magnetic field $\overline{B}^2$. The exception is that in Step 2 the experimenter will enter 14:I, which will give him Display 1660, which applies to measuring the mean square magnetic field $\overline{B}^2$.

    If the experimenter wishes to deviate from the automatic frequency sequence, he can negate it by entering 12:NO on Display 1510 for the $\overline{E}^2$ measurement or entering 12:NO on Display 1610 for the $\overline{B}^2$ measurement. He is then in the manual mode and can set his own transmitter and receiver frequencies. (Display 1510 or 1610, 4:, 5:, 6:, for example.)

12. At the end of the experiment, the experimenter can preserve his last choices of values by backing up to 20 Wave Transmission Experiment Display by (repeatedly) commanding 0:UP. If he wishes to destroy his entries he can enter 0:D from Display 20.

6.1.2 Default Value Displays

The Wave Transmission Experiment is unique among the experiments flow-charted in that two sets of displays are presented—one which permits the experimenter step-by-step control, and one which permits rapid experiment performance via a (partially) automated sequence.

Which path is followed by the experimenter is up to him. By the simple method of not providing his own on-the-spot instrument settings, boom and platform angles, etc., the experimenter in effect forces the computer program to use a set of pre-assigned parameters called default values. There are so many parameters in the plasma physics experiment, that it would be hazardous for the experimenter to rely on his memory for the values of each of these parameters. Yet the experimenter must know these default values in order to control his experiment intelligently. The default values fit into the display background of the experimenter-selected values with regard to number, type, range, and precision. These displays consume negligible additional computer capacity or speed.

It is believed that the AMPS experimenters should seriously consider having default values for each and every parameter where this is plausible. However, in the Wave Transmission Experiment we have presented a set of default value displays in order to illustrate the concept.

6.1.3 Definition of Variables

The following definitions define variables not defined in Section 3.3 of the general Flowcharts and Display Formats discussion.

READY FLAG	A flag indicating whether or not the equipment(s) participating in a particular operation are warmed up or in place. Calculating a ready flag when more than one equipment is involved means calculating when the last equipment necessary to the operation is ready.
$\overline{E}^2$	Mean square value of electric field vector, $(\text{Volts/M})^2$ Range 0 to 10^7, least count 0.1% of full scale displayed value.

$\underline{\overline{B}^2}$	Mean square value of magnetic field vector, $(\text{Tesla})^2$ Range 0 to 10^{-17}, least count 0.1% of full scale displayed value.
PROBE AXIS	The axis of the cylindrical electron probe, mounted so that the probe axis points in the +Y orbiter direction when $X = \psi = \Omega = \theta_A = \phi_A = 0$ degrees.
ELECTRON TEMPERATURE	A measure of the average energy of the electrons in degrees Kelvin. Range 10^2 to 10^7. Least count 0.1% of value.
ELECTRON VOLTS	A measure of the energy of a specific electron or group of electrons, in electron Volts. Range 0 to 1000 least count 0.1% of value at full scale.
ELECTRON DENSITY	The number of free electrons in a cubic meter of plasma.
ANGLE BETWEEN PROBE AXIS AND ORBITER VELOCITY	Measured in the Wave Transmission experiment between the -X orbiter axis and the probe axis.
$\underline{\overline{B}_T}$	The earth's total magnetic field vector at the orbiter, in gamma. Range 0 to 10^5, least count one gamma.
BX, BY, BZ	Components of B_T through the magnetometer X, Y, Z coils. Range and least count same as $\overline{B}_T$. Magnetometer is oriented so that X, Y, Z coil axes are parallel to shuttle X, Y, Z axes when $\Omega = X = \psi = \theta_A = \phi_A = 0$ degrees.
CYCLE	A computer cycle, the time of a major computer update cycle (approximately one or two seconds).

RECEIVER GAIN	The amount of gain in the receiver (pre) amplifier relative to the input signal power in db. Range 0 to 80 db. Least count 1 db. Gain is flat between upper and lower frequency limits.
ROLL OFF	The characteristic way in which response decreases beyond the set frequency limit.
SQU	Square - No signal beyond the frequency limit.
EXP	Exponential decrease in signal level beyond the frequency limit.
LIN	Linear decrease in signal level beyond the frequency limit.
SPECIAL	Special form of decrease in signal level beyond the frequency limit.
S^2	Signal level ratio S^2. The proportion by which P_{max} is reduced for the Wave Transmission experiment. Range 0 to 1.000 Least count 0.1% of its value.
TRANSMITTER ATTENUATOR	The attenuation inserted between the transmitter and the transmitting antenna, in db. Attenuation in power ranges from 0 to -80 db. Least count 1 db.
(TRANSMITTING) ANTENNA LENGTH d	The tip-to-tip length of the transmitting antenna. Range 0.0 to 33.0 meters. Least count 0.1 meters.
AUTOMATIC FREQUENCY BANDWIDTH	An equal tolerance about the center transmitter frequency. Applied to the upper and lower receiver frequencies, respectively. Range 0 to 9.99 MHz. Least count 0.01 MHz.

AUTOMATIC FREQUENCY SEQUENCE	A sequence of frequencies preplanned for the Wave Transmission experiment.
NEXT VALUE OF FREQUENCY	Next value in the automatic sequence.
PREVIOUS VALUE OF FREQUENCY	Previous value in the automatic sequence. Used to redo a measurement if necessary.
RECORD INSTRUMENT SETTINGS	Record all values set by the experimenter for the instruments that are ON.
r	Effective distance between transmitter and receiver. Range 2 to 100 meters. Least count 0.1 meters.
m	The mass of the electron (Kilograms).
P_{max}	The maximum power of the transmitter that can be used for this experiment (1000 Watts).
e	The charge of the electron (coulombs).
k	The wave number of the transmitted wave (seconds/meter).
c	The velocity of light (meters/second).
w	The frequency of the transmitted signal in radians/second. $w = 2\pi f$.

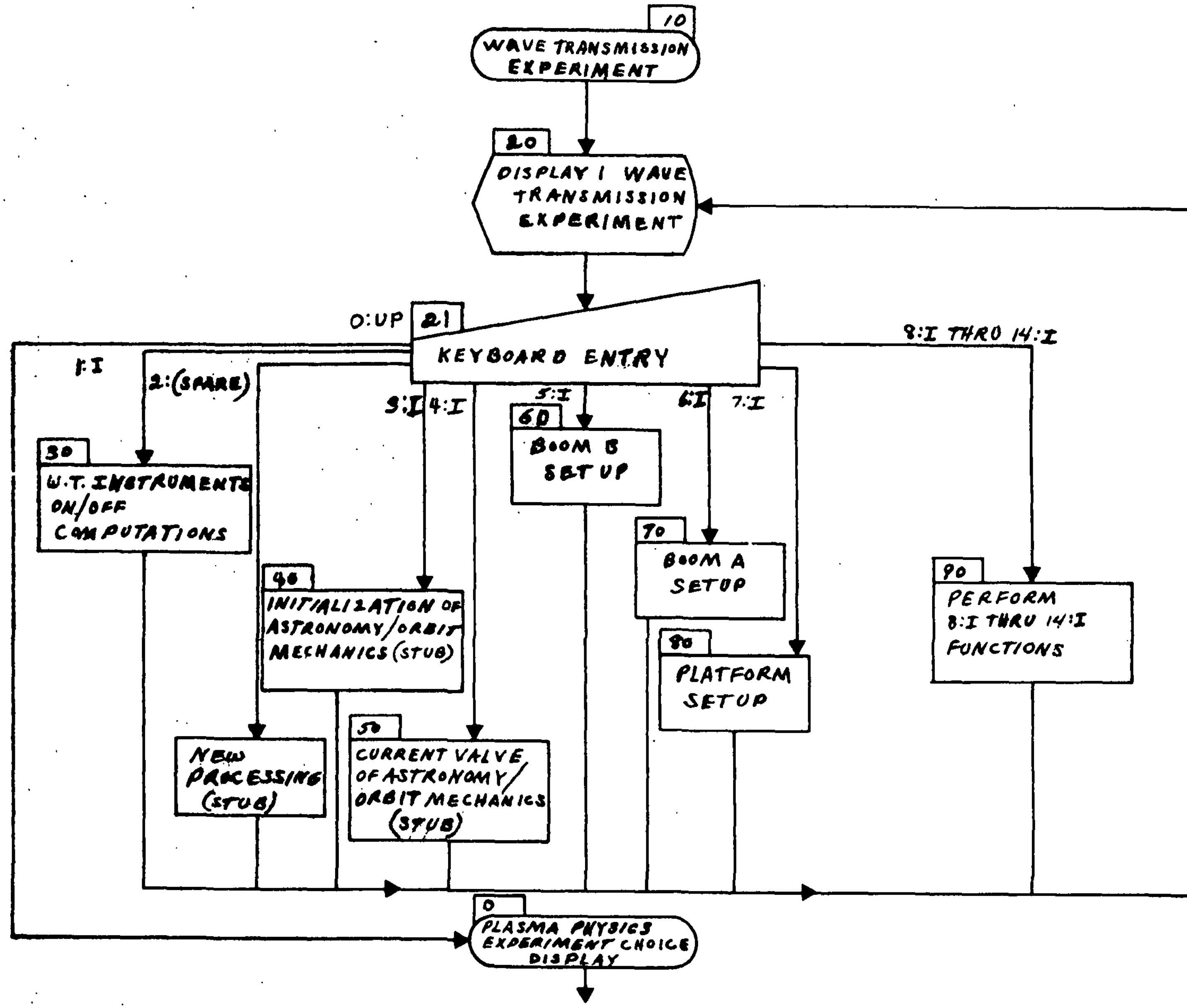
XYZ	Cartesian coordinate system (right handed) fixed in Orbiter. X-axis = longitudinal axis of vehicle positive rearward Y-axis = positive out right "wing" Z-axis = positive upward
L_B, Θ_B, ϕ_B	Boom "B" tip spherical coordinate system where L_B = Boom "B" length Θ_B = Boom "B" elevation-measured from Orbiter + Z-axis ϕ_B = Boom "B" azimuth-measured from Orbiter + X-axis positive about Z
L_A, Θ_A, ϕ_A	Boom "A" spherical coordinate system where L_A = Boom "A" length Θ_A = Boom "A" elevation measured from Orbiter + Z-axis ϕ_A = Boom "A" azimuth measured from Orbiter + X-axis positive about Z.
x, y, z	Cartesian coordinate system fixed in Boom "B" with origin at boom tip where; z-axis is positive outward along Boom "B". x & y axes are normal to z forming a rectangular right-handed system. xyz coincides with Orbiter XYZ when $L_B = \Theta_B = \phi_B = 0$

Ω, χ, Ψ	Eulerian angles specifying platform orientation.
	Ω = *Inclination angle positive about an axis in the* platform plane coinciding with the line of nodes.
	χ = Angle between line of nodes and a fixed axis in the plane normal to the Boom "A". Positive about outward boom axis.
	Ψ = Angle between line-of-nodes and a fixed axis in the platform plane.

6.1.4 FLOWCHARTS AND DISPLAY FORMATS FOR THE WAVE TRANSMISSION EXPERIMENT

10 FUNCTIONAL DESCRIPTION

This flowchart, together with 90, shows the principal functional blocks into which the Wave Transmission Experiment has been broken down.



20

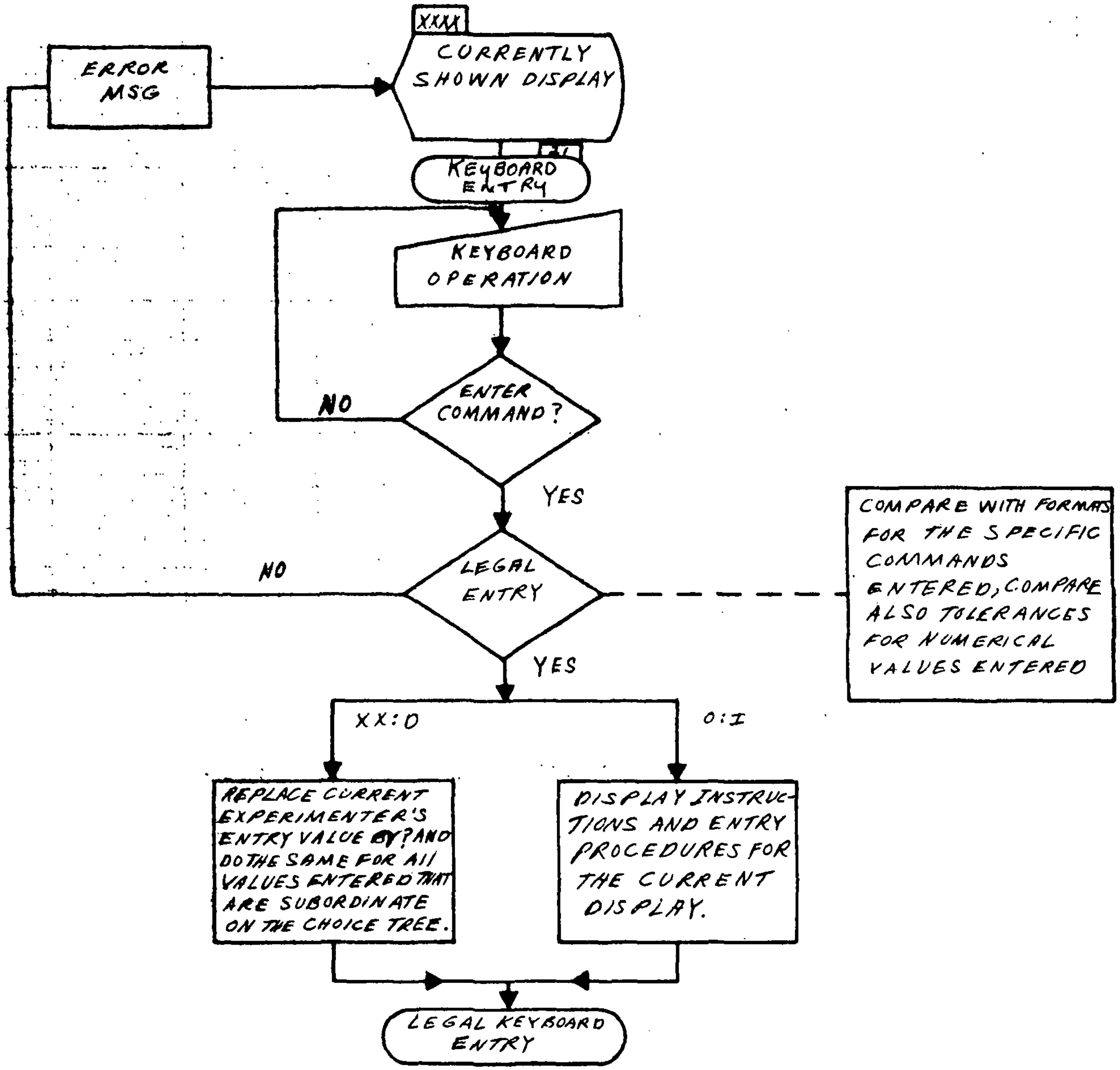
WAVE TRANSMISSION EXPERIMENT DISPLAY

ERROR MSG:

0:	PROCEDURES UP TO PLASMA PHYSICS CHOICE DISPLAY	_____ UP/I/D	8:	CYL. EL. PROBE SETUP	_____ I/D
1:	W. T. INSTRUMENTS ON/OFF	_____ ON/OFF	9:	FLUXGATE MAGNETOMETER SETUP	_____ I/D
		☐ READY	10:	ELECTRIC FIELD RECEIVER SETUP	_____ I/D
2:	SPARE		11:	MAGNETIC FIELD RECEIVER SETUP	_____ I/D
3:	INITIALIZATION OF ASTRONOMY AND ORBIT MECHANICS	_____ I/D	12:	TRANSMITTER SETUP	_____ I/D
4:	CURRENT VALUE OF ASTRONOMY AND ORBIT MECHANICS	_____ I/D	13:	WAVE TRANSMISSION EXPERIMENT $\overline{E}^2$ DATA	_____ I/D
5:	BOOM B SETUP	_____ I/D	14:	WAVE TRANSMISSION EXPERIMENT $\overline{B}^2$ DATA	_____ I/D
6:	BOOM A SETUP	_____ I/D			
7:	PLATFORM SETUP	_____ I/D			

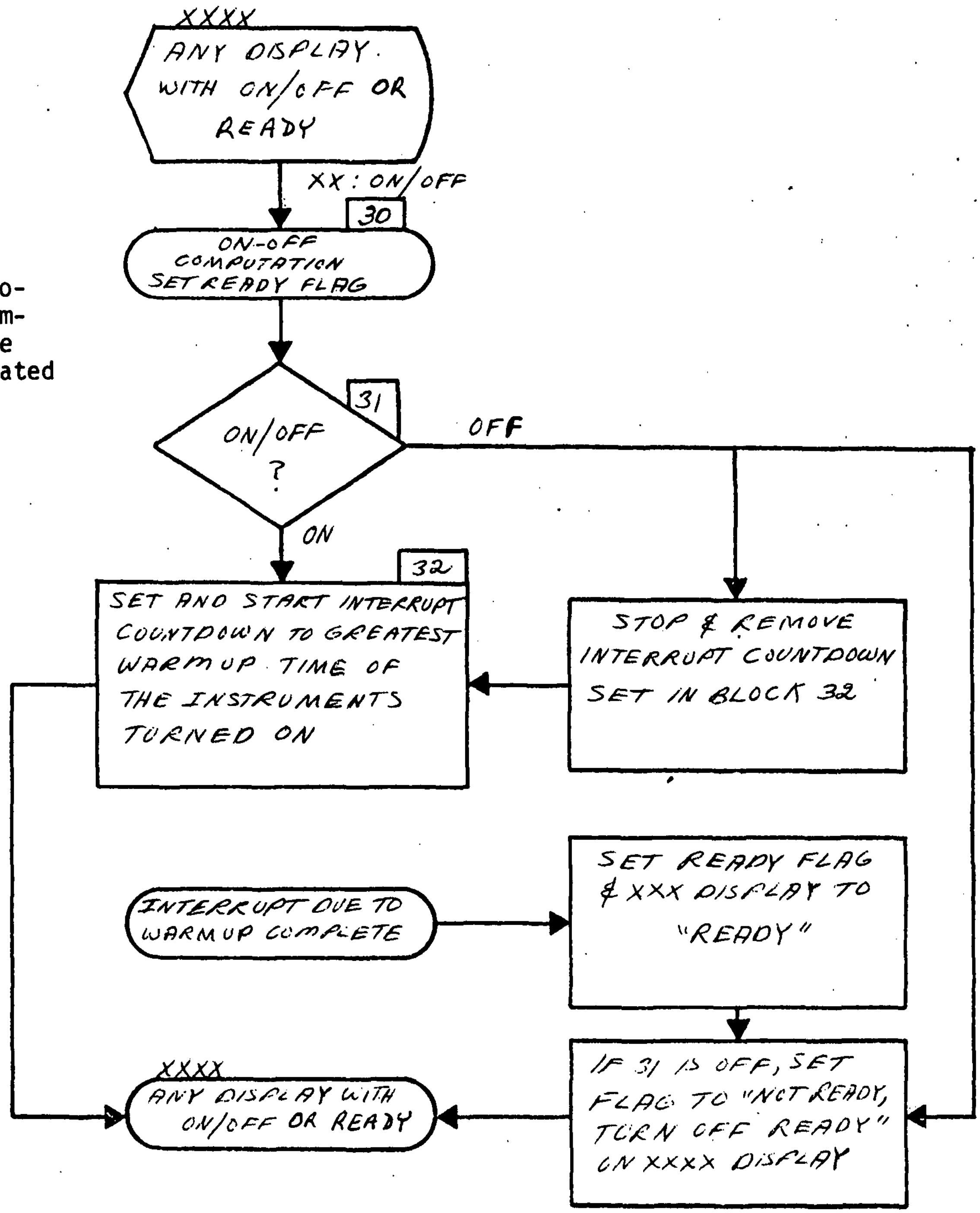
21 FUNCTIONAL DESCRIPTION

This flowchart shows the preliminary processing performed to determine whether the commands entered via the MFDS Keyboard are legal or not. it also shows the processing of two commonly used commands. In the Symbol XX:D, the XX stands for any entry number used by the operator.



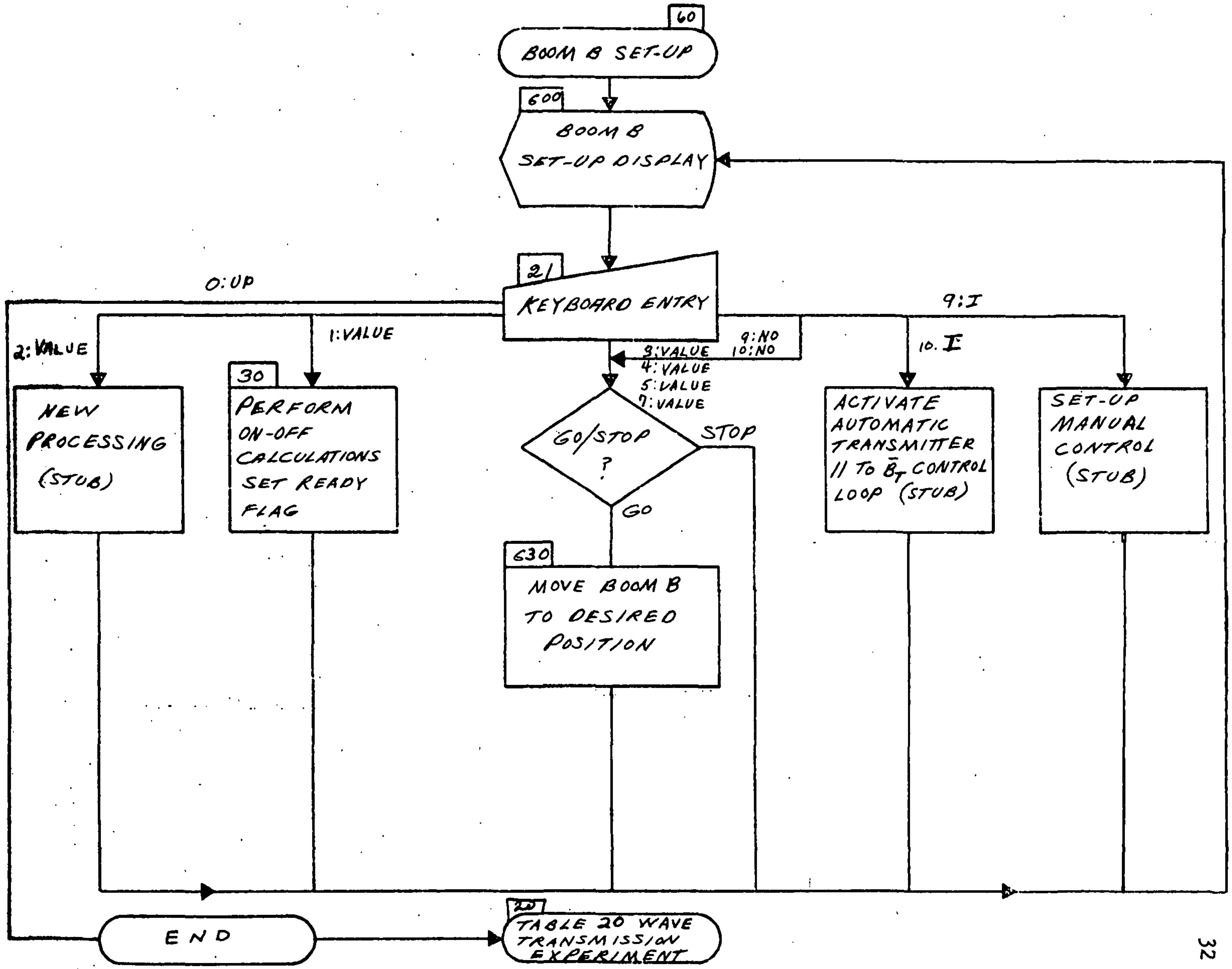
30 FUNCTIONAL DESCRIPTION

This flowchart shows the processing to simulate the warm-up time due to switching the electronic equipment associated with this experiment on or off. The interrupt due to warmup complete can have a low priority, since a few seconds more warmup time will not affect the results of the experiment significantly.



60 FUNCTIONAL DESCRIPTION

This chart shows the functions required to activate and display the set-up of Boom "B" for the WT experiment. The desired Boom "B" tip coordinates are entered by 3:, 4:, and 5: and boom motion initiated by entry in 7:. Current coordinates can be monitored on the display, however, changing the display does not halt the computation. Upon close-out of the "desired minus actual" errors, the READY display is activated.



600 BOOM B SETUP DISPLAY

ERROR MSG:

0: PROCEDURES & ENTRY INSTRUCTIONS ______ UP/I
UP TO WAVE TRANSMISSION
EXPERIMENT DISPLAY

1: BOOM B ______ ON/OFF

READY

2: SPARE

BOOM B POSITION

	DESIRED	ACTUAL	
3: LENGTH	______		XX.X METERS
4: ELEVATION	______		XX. DEG FROM ORBITER +Z
5: AZIMUTH	______		XXX. DEG FROM ORBITER +X

6: SPARE

7: MOVE BOOM TO DESIRED POSITION ______ GO/STOP

BOOM B CONTROL MODES

8: SPARE

9: MANUAL CONTROL MODE ______ NO/I

10: TRANSMITTING ANTENNA PARALLEL ______ NO/I
TO $\overline{B}_T$ (AUTOMATIC)

601 BOOM B SETUP DISPLAY
(DEFAULT VALUES)

ERROR MSG:

0: PROCEDURES & ENTRY INSTRUCTIONS ____ UP/I
UP TO BOOM B SETUP
DISPLAY

1: BOOM B ON ON/OFF

[ ] READY

2: SPARE

BOOM B POSITION

		DESIRED	ACTUAL	
3:	LENGTH	50.0	[ ]	XX.X METERS
4:	ELEVATION	30.	[ ]	XX. DEG FROM ORBITER +Z
5:	AZIMUTH	0.	[ ]	XXX. DEG FROM ORBITER +X

6: SPARE

7: MOVE BOOM TO DESIRED POSITION GO GO/STOP

BOOM B CONTROL MODES

8: SPARE

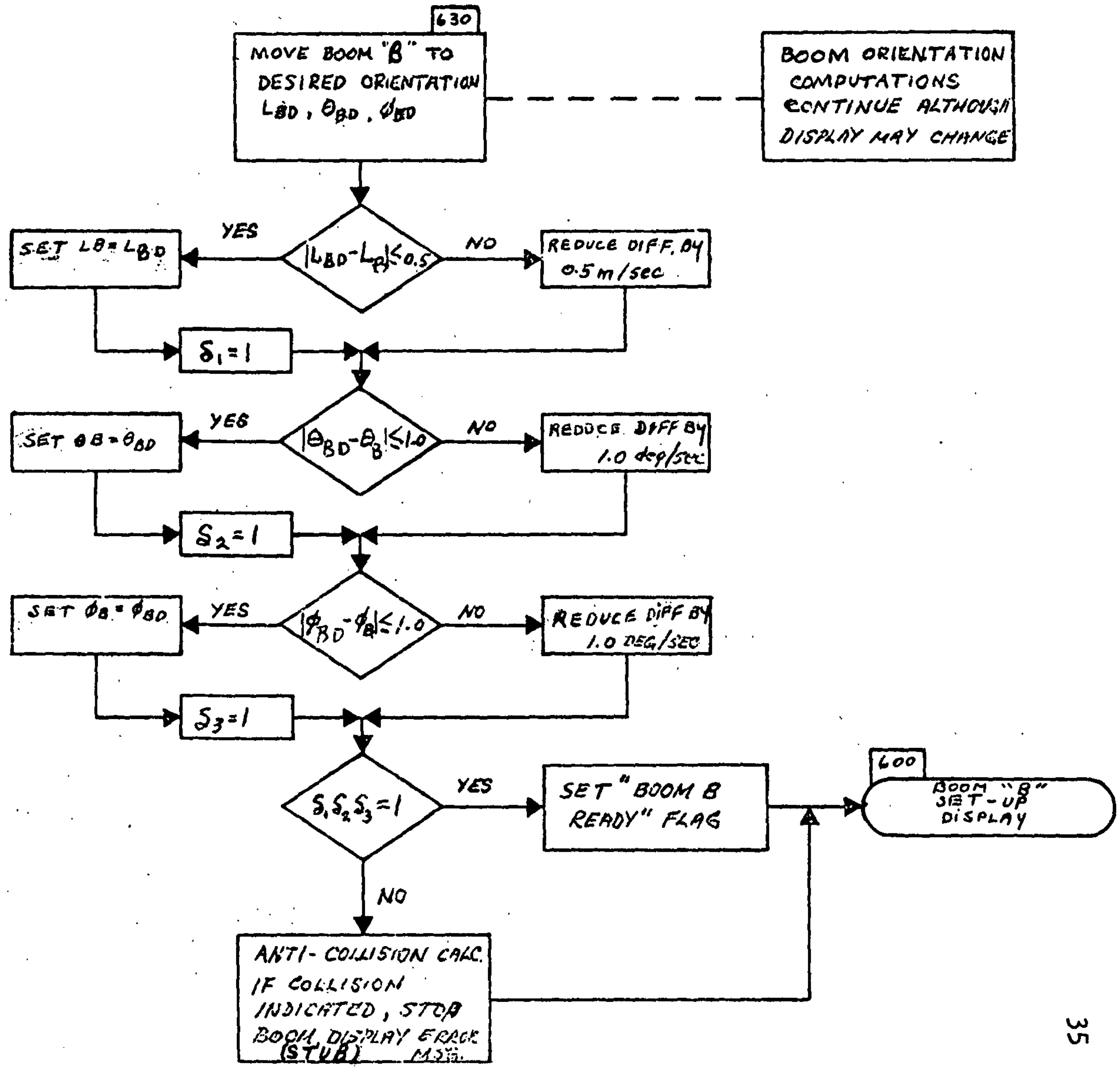
9: MANUAL CONTROL MODE NO NO/I

10: TRANSMITTING ANTENNA PARALLEL TO $\overline{B}_T$ (AUTOMATIC) NO NO/I

630 FUNCTIONAL DESCRIPTION

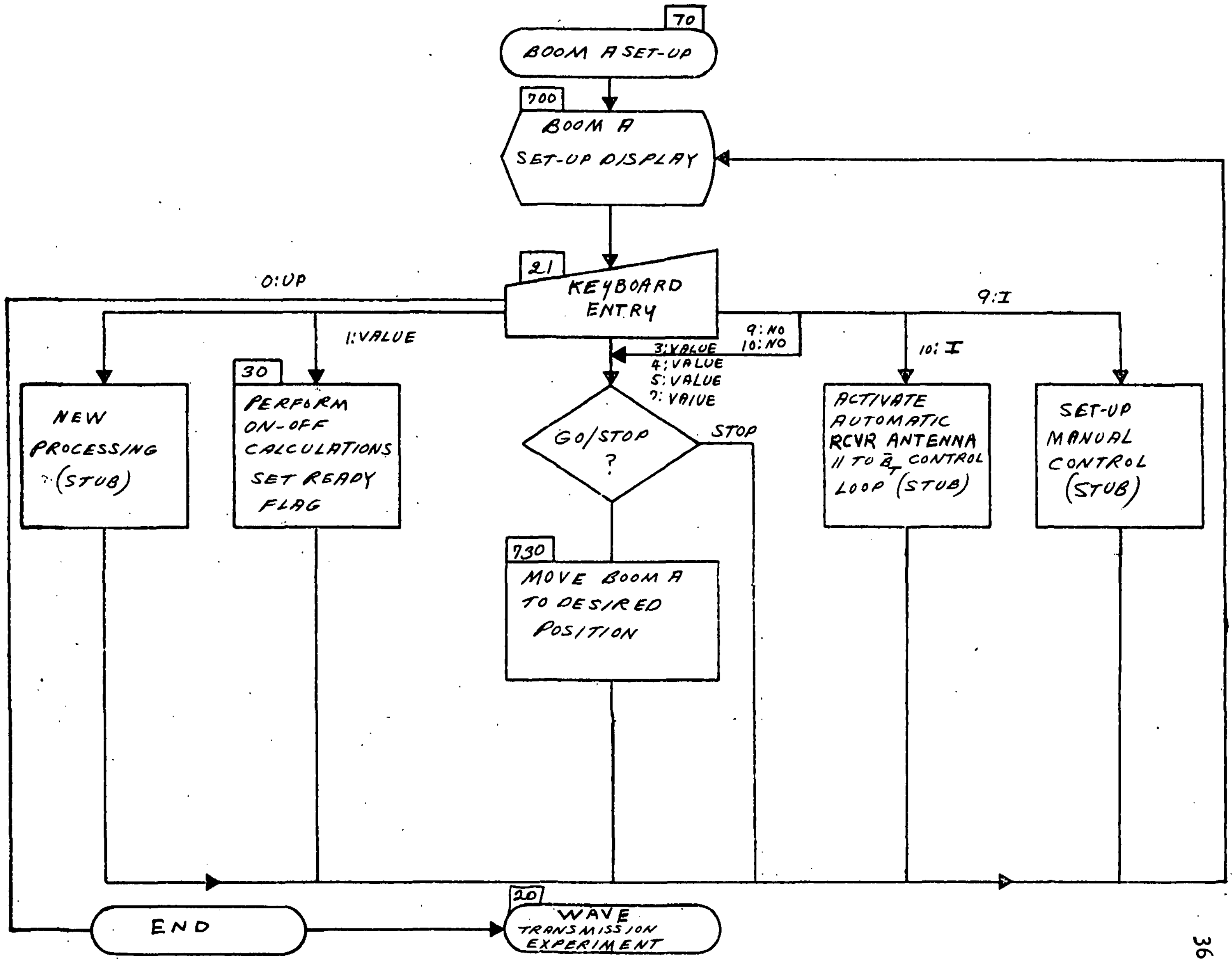
This chart is an expansion of the functions required, under the "Boom B Set-Up" routine, to orient Boom "B" to the desired length, azimuth and elevation. Current values of these parameters are checked each cycle until all three are at the desired value, within a specified tolerance. The boom motion is then stopped and a "READY" flag is set.

Note that an anti-collision or "safety" computation, as yet undefined, is performed with each change in boom coordinates.



70 FUNCTIONAL DESCRIPTION

This chart shows the functions required to activate and display the setup of Boom A for the WT experiment. The desired Boom A tip coordinates are entered by 3:, 4:, and 5: and boom motion initiated by entry in 7:. Current coordinates can be monitored on the display, however, changing the display does not halt the computation. Upon close-out of the "desired minus actual" errors, the READY display is activated.



700 BOOM A SETUP DISPLAY

ERROR MSG:

0: PROCEDURES & ENTRY INSTRUCTIONS ____ UP/I
UP TO WAVE TRANSMISSION
EXPERIMENT DISPLAY

1: BOOM A ____ ON/OFF

☐ READY

2: SPARE

BOOM A POSITION

	DESIRED	ACTUAL	
3: LENGTH	____	☐	XX.X METERS
4: ELEVATION	____	☐	XX. DEG FROM ORBITER +Z
5: AZIMUTH	____	☐	XXX. DEG FROM ORBITER +X

6: SPARE

7: MOVE BOOM TO DESIRED POSITION ____ GO/STOP

BOOM A CONTROL MODES

8: SPARE

9: MANUAL CONTROL MODE ____ NO/I

10: RECEIVING DIPOLE ANTENNA PARALLEL TO B_T (AUTOMATIC) ____ NO/I

701 BOOM A SETUP DISPLAY
(DEFAULT DISPLAY)

ERROR MSG.

0: PROCEDURES & ENTRY INSTRUCTIONS ________ UP/I
UP TO BOOM A SETUP
DISPLAY

1: BOOM A ON ON/OFF

[ ] READY

2: SPARE

BOOM A POSITION

	DESIRED	ACTUAL	
3: LENGTH	50.0	[ ]	XX.X METERS
4: ELEVATION	30.	[ ]	XX. DEG FROM ORBITER +Z
5: AZIMUTH	180.	[ ]	XXX. DEG FROM ORBITER +X

6: SPARE

7: MOVE BOOM TO DESIRED POSITION GO GO/STOP

BOOM A CONTROL MODES

8: SPARE

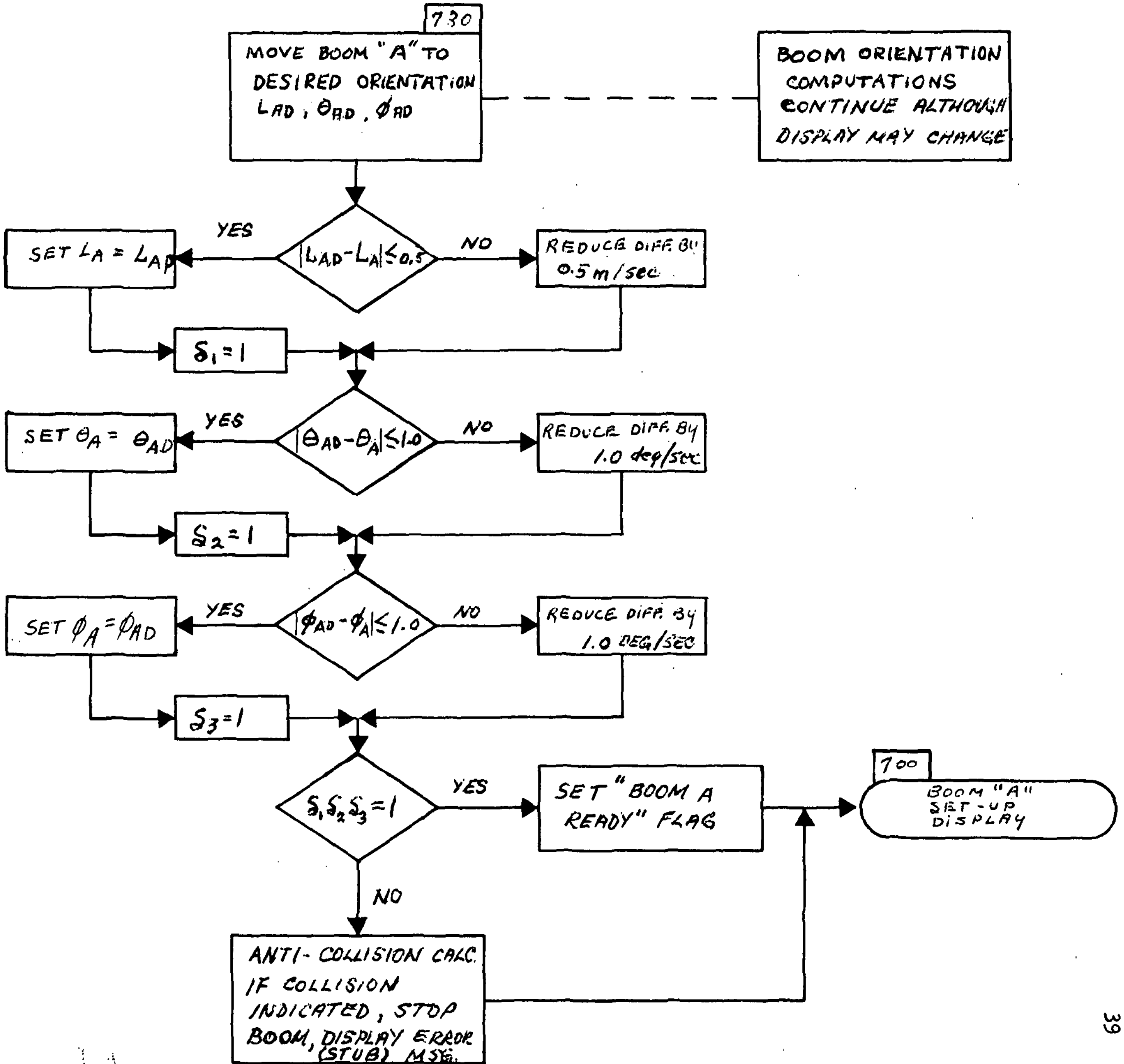
9: MANUAL CONTROL MODE NO NO/I

10: RECEIVING DIPOLE ANTENNA NO NO/I
PARALLEL TO B_T (AUTOMATIC)

730 FUNCTIONAL DESCRIPTION:

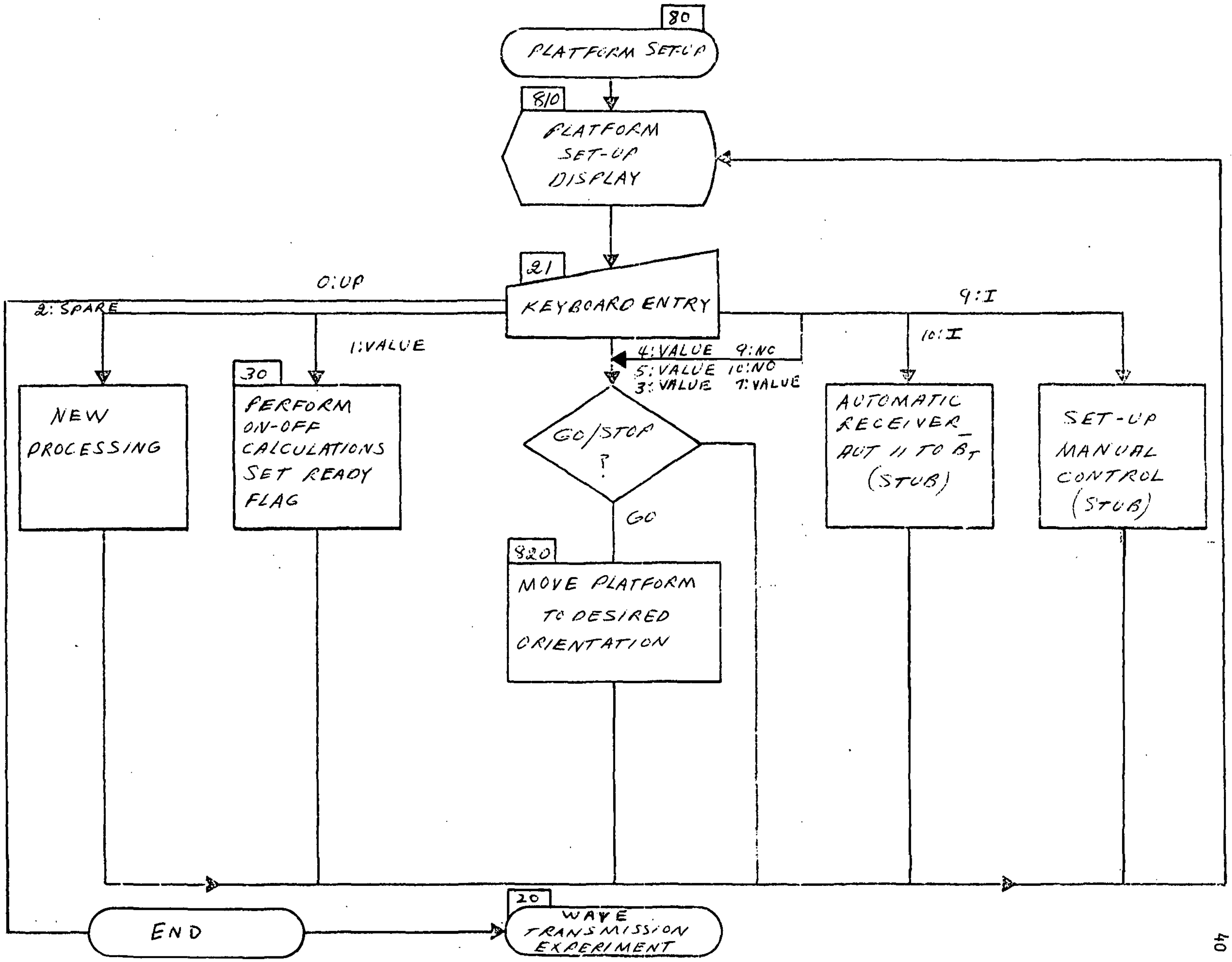
This chart is an expansion of the functions required, under the "Boom A Set-Up" routine, to orient Boom "A" to the desired length, azimuth and elevation. Current values of these parameters are checked each cycle until all three are at the desired value, within a specified tolerance. The boom motion is then stopped and a "READY" flag is set.

Note that an anti-collision or "safety" computation, as yet undefined, is performed with each change in boom coordinates.



80 FUNCTIONAL DESCRIPTION:

This chart shows the functions required to activate and display the set-up of the gimbaled platform on the tip of Boom "A". The desired platform orientation (Inclination Ω, Right Ascension ψ, and Line of Nodes χ) is entered by 3:, 4:, and 5: and platform motion initiated by 7:. Current values of these parameters can be monitored on the display, however, changing the display does not halt the angle computations. Upon close-out of the "desired minus actual" errors, the READY display is activated.



810 PLATFORM SETUP DISPLAY

ERROR MSG:

0: PROCEDURES & ENTRY INSTRUCTIONS UP TO WAVE TRANSMISSION EXPERIMENT ______ UP/I/D

1: PLATFORM MOVE CONTROL ______ ON/OFF

READY

2: SPARE

PLATFORM ORIENTATION

	DESIRED	ACTUAL	
3: INCLINATION Ω	______		XX DEG FROM BOOM $\hat{x}_3'$
4: RIGHT ASC ψ	______		XX DEG FROM LN
5: LINE OF NODES χ	______		XX DEG FROM BOOM $\hat{x}_1'$

6: SPARE

7: MOVE PLATFORM TO DESIRED ORIENTATION ______ GO/STOP

PLATFORM CONTROL MODES

8: SPARE

9: MANUAL CONTROL MODE ______ NO/I

10: RECEIVING DIPOLE ANTENNA PARALLEL TO $\overline{B}_T$ (AUTOMATIC) ______ NO/I

811 PLATFORM SETUP DISPLAY
(DEFAULT VALUES)

ERROR MSG:

0: PROCEDURES & ENTRY INSTRUCTIONS UP TO PLATFORM SETUP DISPLAY ____ UP/I/D

1: PLATFORM MOVE CONTROL ON ON/OFF

[ ] READY

2: SPARE

PLATFORM ORIENTATION

DESIRED ACTUAL

3: INCLINATION Ω 0 [ ] XX DEG FROM BOOM $\hat{x}_3'$

4: RIGHT ASC ψ 0 [ ] XX DEG FROM LN

5: LINE OF NODES χ 0 [ ] XX DEG FROM BOOM $\hat{x}_1'$

6: SPARE

7: MOVE PLATFORM TO DESIRED ORIENTATION GO GO/STOP

PLATFORM CONTROL MODES

8: SPARE

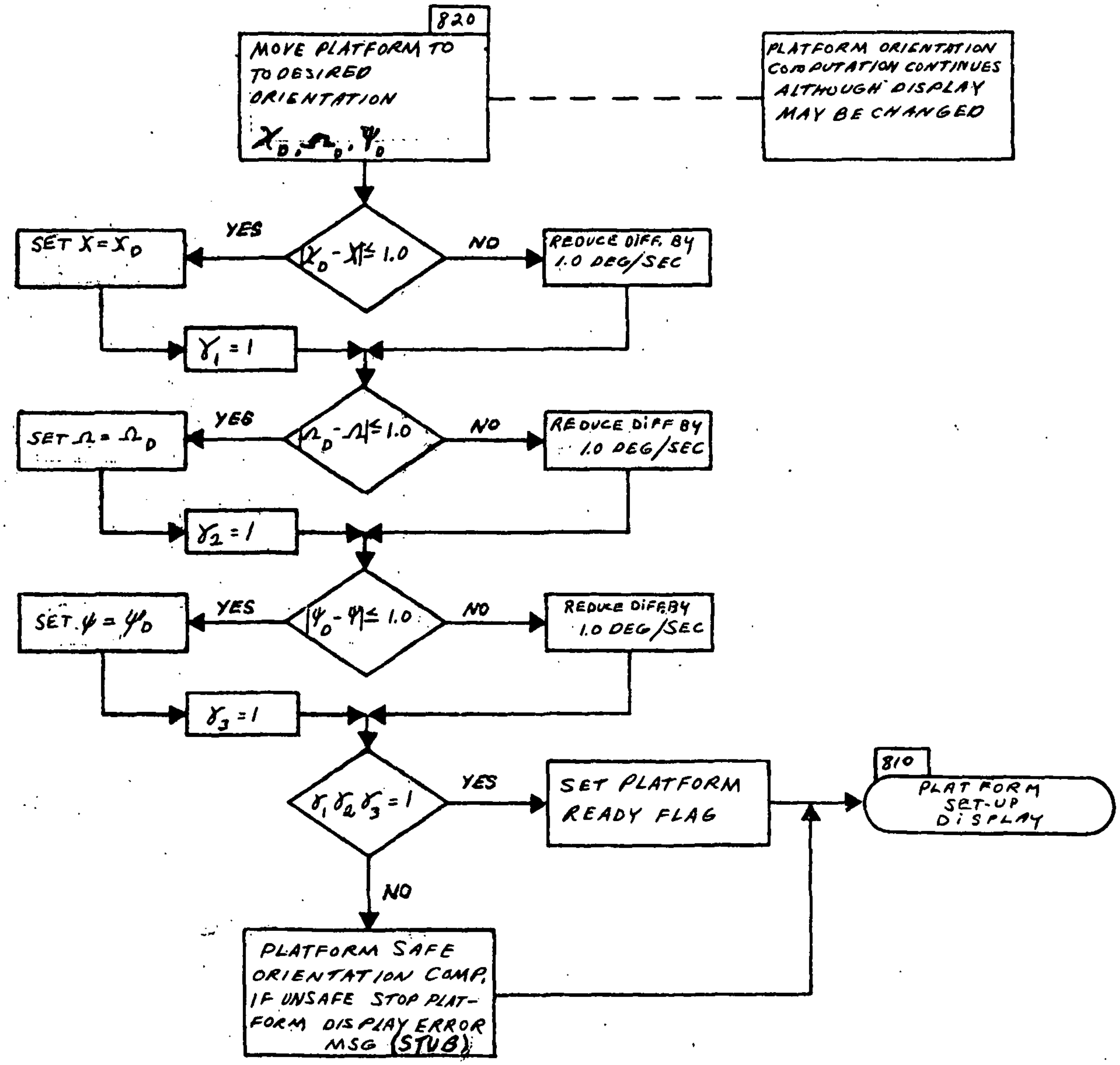
9: MANUAL CONTROL MODE NO NO/I

10: RECEIVING DIPOLE ANTENNA PARALLEL TO $\bar{B}_T$ (AUTOMATIC) NO NO/I

820 FUNCTIONAL DESCRIPTION

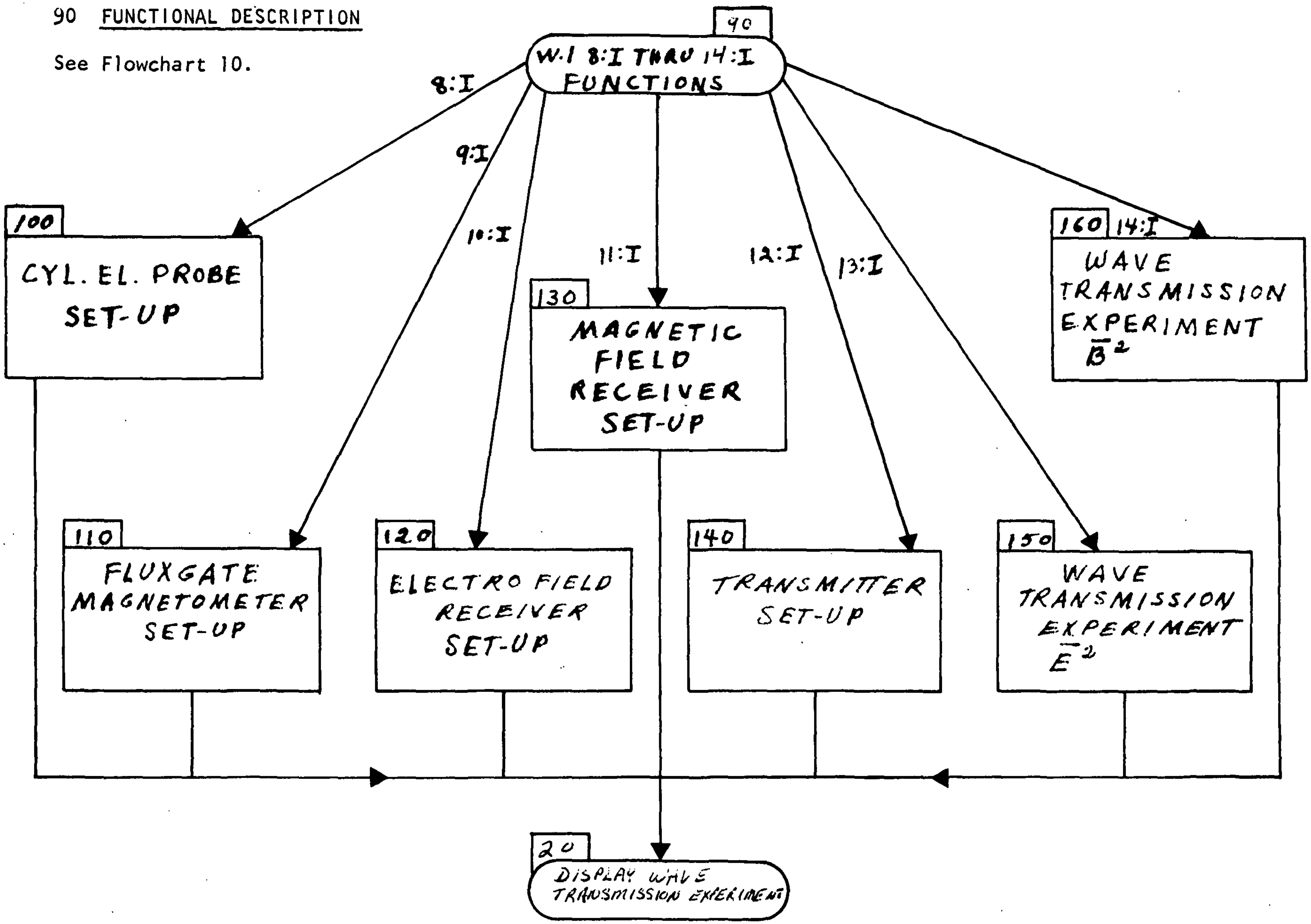
This chart is an expansion of the functions required, under the "Platform Setup" routine, to orient the platform to the desired angular orientation with regard to the Line of Nodes and Inclination. The Euler angles Ω, χ, Ψ, are checked each cycle until all three are at the pre-set desired value, within a specified tolerance. Platform motion is then stopped and the "Platform Ready" flag is set.

Note that a "Platform Safe Orientation" computation, as yet unidentified, is performed each cycle after changing the platform angles.



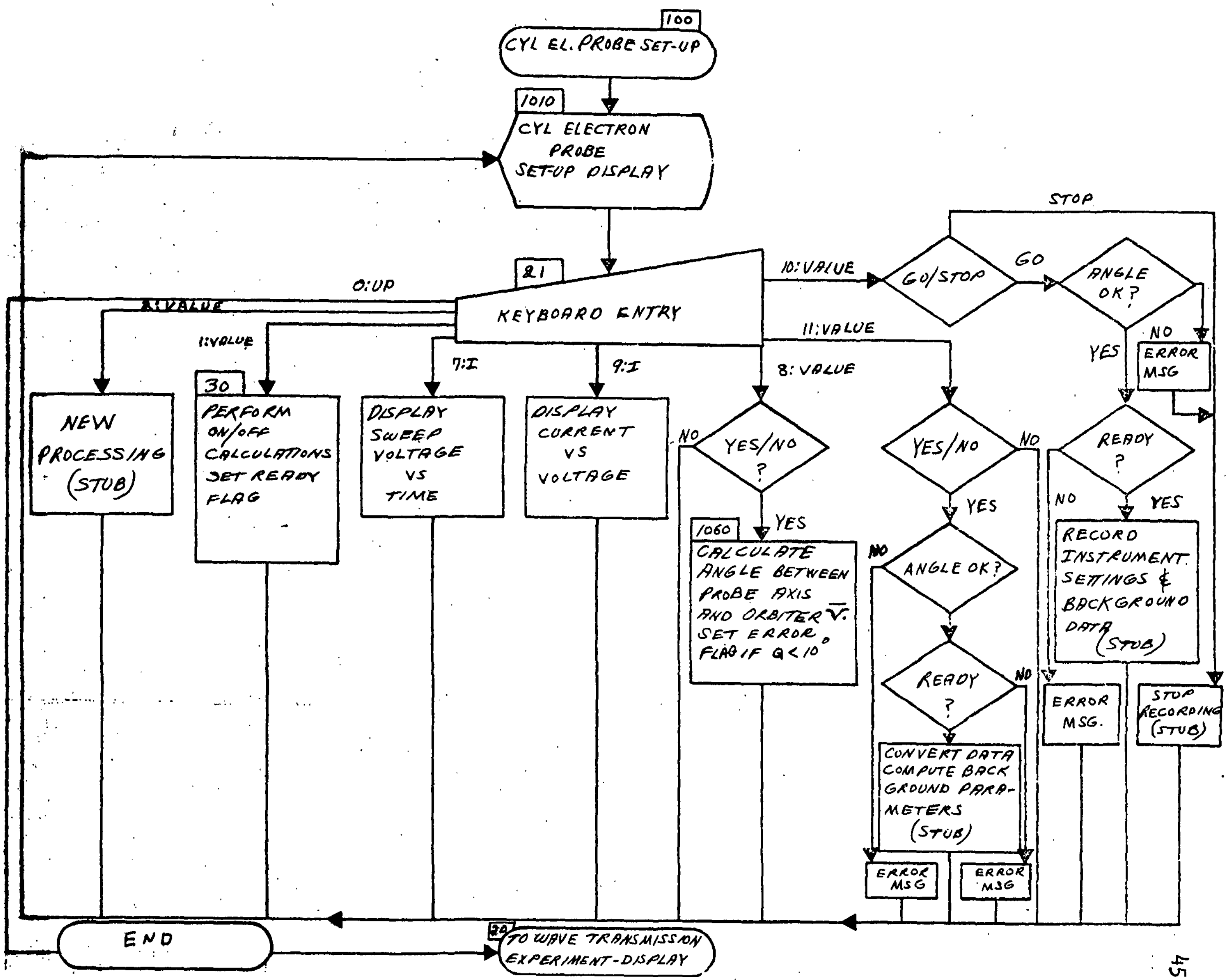
90 FUNCTIONAL DESCRIPTION

See Flowchart 10.



100 FUNCTIONAL DESCRIPTION

This flowchart shows the processing of the set up of the cylindrical electron probe instrument, including checks on probe sweep and current vs. voltage relationship. This flow also shows checks made preliminary to processing the electron density background measurements and recording of these measurements. These latter two functions are stubbed. However, a default value is provided in the output displays where electron density is used.



1010 CYLINDRICAL ELECTRON
PROBE SETUP DISPLAY

ERROR MSG:

0: PROCEDURES & ENTRY INSTRUCTIONS UP TO WAVE TRANSMISSION EXPERIMENT DISPLAY ______ UP/I/D

1: PROBE ______ ON/OFF

[ ] READY

2: SPARE

3: SPARE

4: SPARE

5: SPARE

6: SPARE

7: DISPLAY SWEEP VOLTAGE ______ I/NO

ANGLE BETWEEN PROBE AXIS & ORBITER VELOCITY $\bar{V}$

8: COMPUTE ANGLE [ ] DEGREES ______ YES/NO

9: DISPLAY CURRENT VS. VOLTAGE ______ I/NO

10: RECORD SETTINGS/BACKGROUND DATA ______ GO/STOP

11: COMPUTE ELECTRON BACKGROUND PARAMETERS ______ YES/NO

ELECTRON TEMPERATURE [ ] DEG K

ELECTRON VOLTS [ ] eV

ELECTRON DENSITY n_e [ ] e/M^3

1011 CYLINDRICAL ELECTRON
PROBE SETUP DISPLAY
(DEFAULT VALUES)

ERROR MSG:

0: PROCEDURES & ENTRY INSTRUCTIONS UP TO CYLINDRICAL ELECTRON PROBE SETUP DISPLAY ______ UP/I

1: PROBE ON ON/OFF

[ ] READY

2: SPARE

3: SPARE

4: SPARE

5: SPARE

6: SPARE

7: DISPLAY SWEEP VOLTAGE NO I/NO

ANGLE BETWEEN PROBE AXIS & ORBITER VELOCITY V

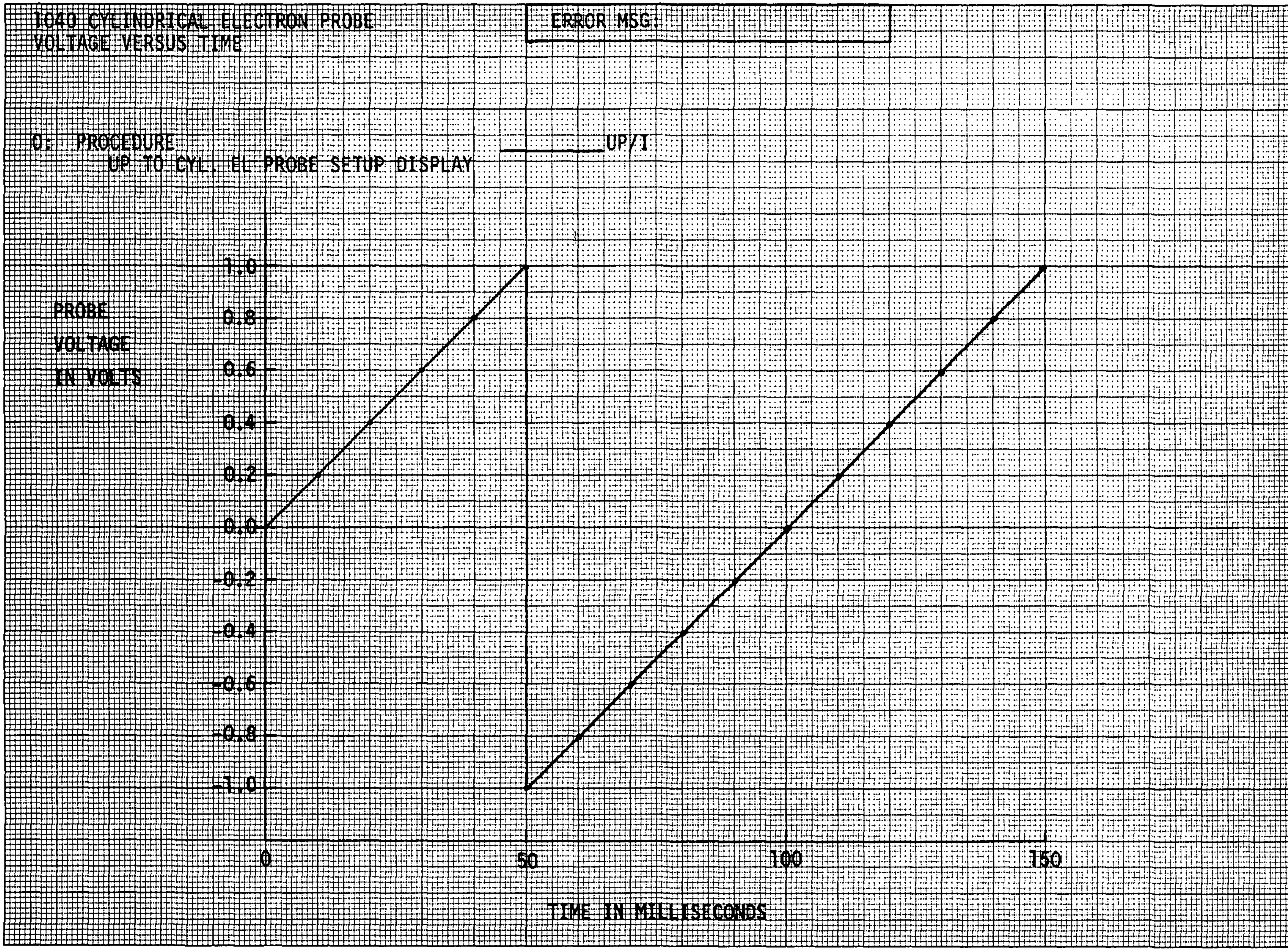
8: COMPUTE ANGLE [90 DEGREES] ______ YES/NO

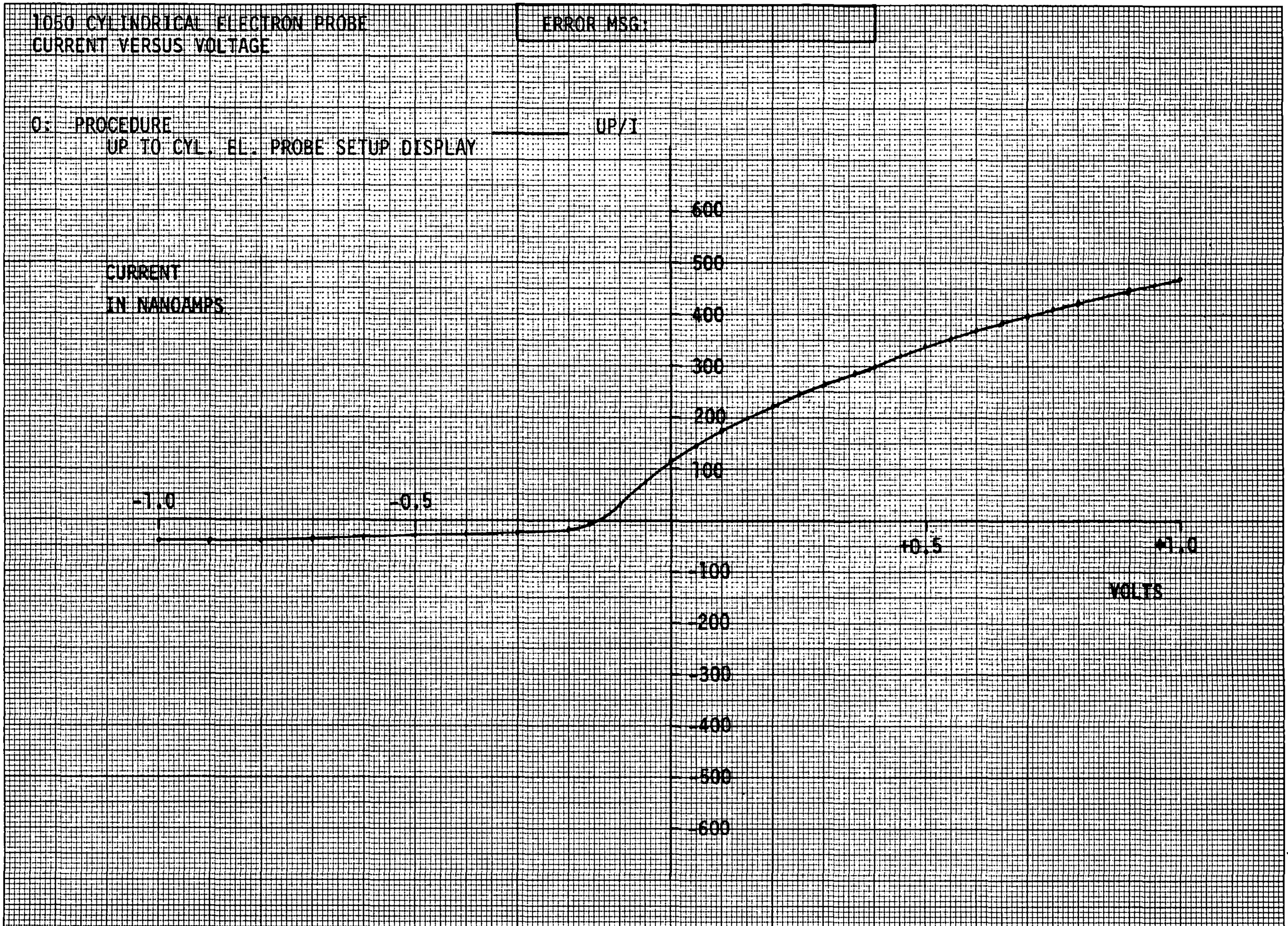
9: DISPLAY CURRENT VS. VOLTAGE NO I/NO

10: RECORD SETTINGS/BACKGROUND DATA STOP GO/STOP

11: COMPUTE ELECTRON BACKGROUND PARAMETERS YES YES/NO

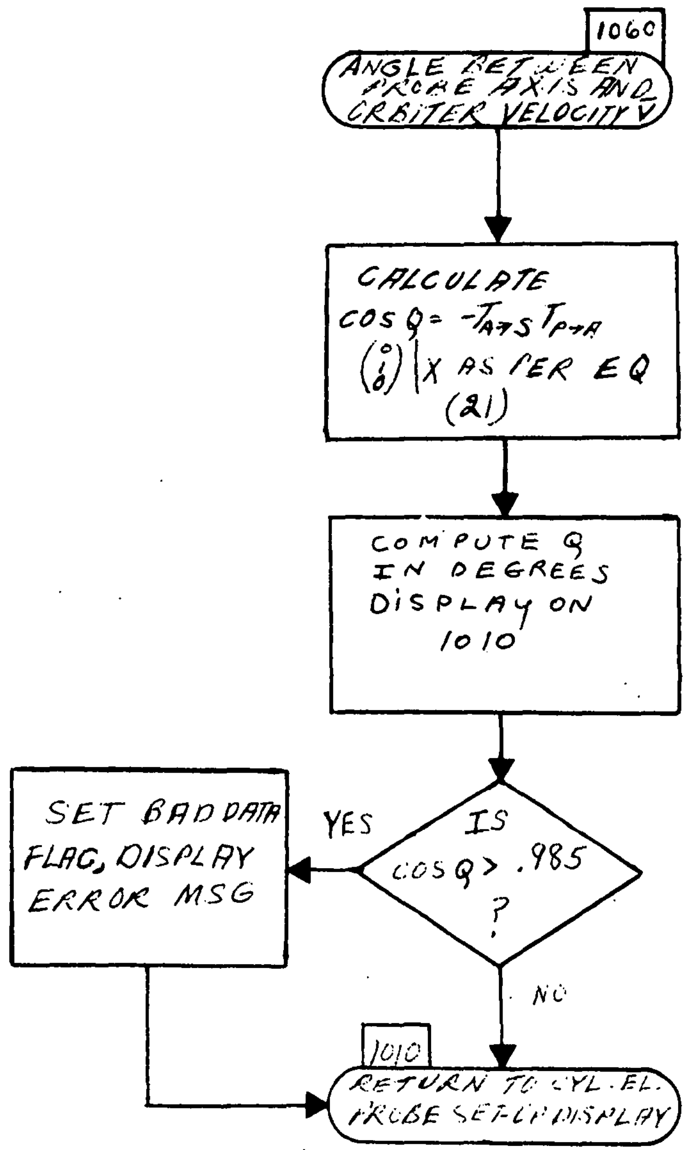
ELECTRON TEMPERATURE	1161	DEG K
ELECTRON VOLTS	0.1	eV
ELECTRON DENSITY n_e	3.0E11	e/M^3


1040 CYLINDRICAL ELECTRON PROBE
VOLTAGE VERSUS TIME
ERROR MSG:
0: PROCEDURE
UP TO CYL. EL PROBE SETUP DISPLAY
UP/I
PROBE
VOLTAGE
IN VOLTS
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
50
100
150
TIME IN MILLISECONDS


1050 CYLINDRICAL ELECTRON PROBE
CURRENT VERSUS VOLTAGE
ERROR MSG:
0: PROCEDURE
UP TO CYL. EL. PROBE SETUP DISPLAY
UP/I
CURRENT
IN NANOAMPS
600
500
400
300
200
100
-100
-200
-300
-400
-500
-600
-1.0
-0.5
+0.5
+1.0
VOLTS

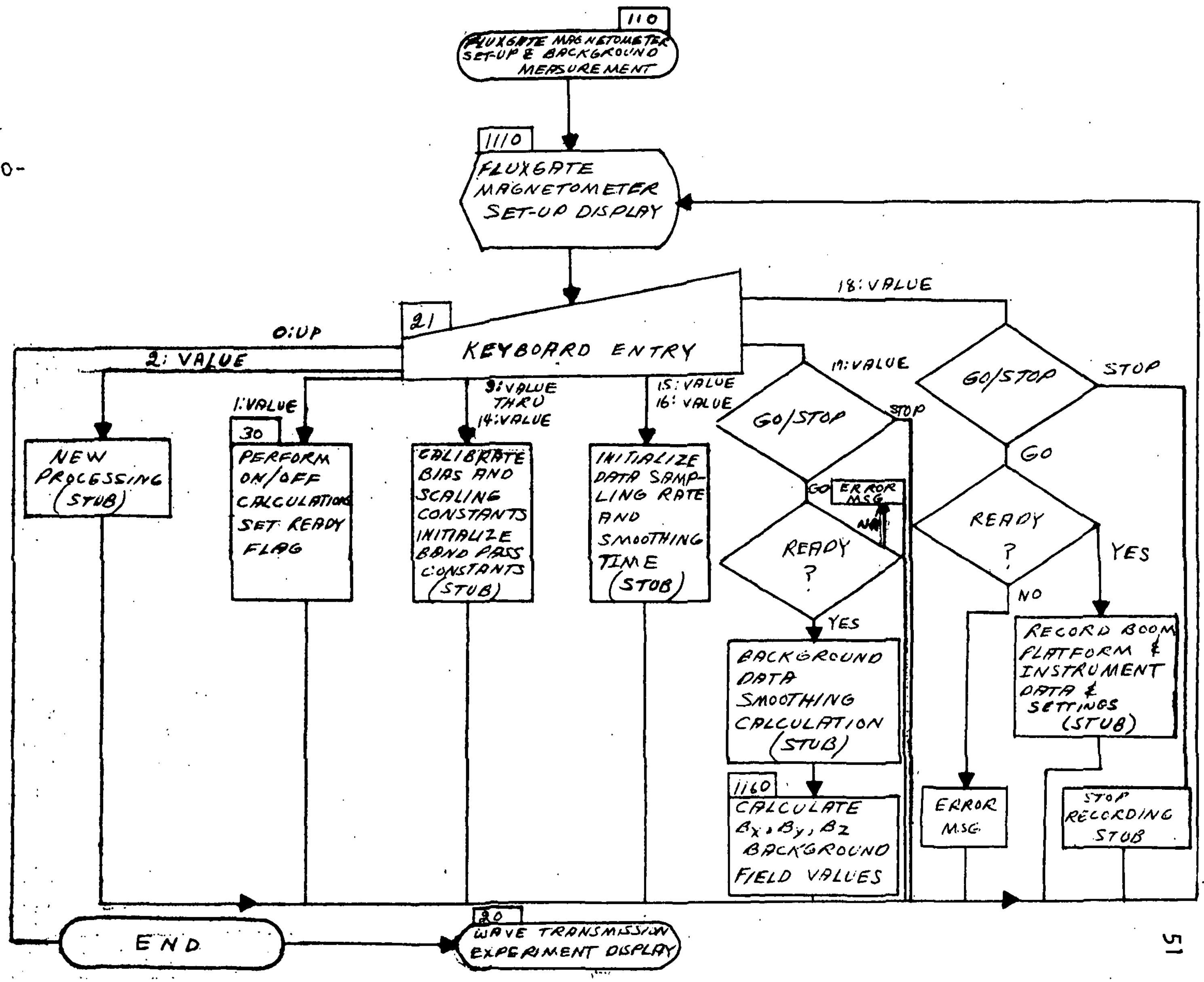
1060 FUNCTIONAL DESCRIPTION

This flowchart shows the probe angle calculation. In the Wave Transmission experiment the normal probe orientation would be at 90° to the velocity vector. If cos Q is greater than .985 (10°) a very large error (80°) has been made.



110 FUNCTIONAL DESCRIPTION

This flowchart shows the processing of the setup of the triaxial fluxgate magnetometer, including its initialization constants. This flow also shows the processing necessary for making background measurements and recording of the background data. Default values assume that the magnetometer is perfectly lined up with the Y coil perpendicular to the earth's magnetic field.



1110 FLUXGATE MAGNETOMETER SETUP DISPLAY

ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS ______ UP/I/D
UP TO WAVE TRANSMISSION
EXPERIMENT DISPLAY

1: MAGNETOMETER ______ ON/OFF

READY

2: SPARE

COIL BIAS, SCALE FACTOR, BANDPASS

3: SPARE

4: SPARE

5: SPARE

6: SPARE

7: SPARE

8: SPARE

9: SPARE

10: SPARE

11: SPARE

12: SPARE

13: SPARE

14: SPARE

15: TAKE DATA ______ TIMES PER CYCLE

16: AVERAGE OVER ______ CYCLES

17: BACKGROUND MEASUREMENTS ______ GO/STOP

BACKGROUND B-FIELD VALUES		
BX	______	GAMMA
BY	______	GAMMA
BZ	______	GAMMA
BT	______	GAMMA
CYCLOTR. FREQ.		KHz

18: RECORD BACKGROUND ______ GO/STOP

NO. 341-M DIETZGEN GRAPH PAPER MILLIMETER

EUGENE DIETZGEN CO. MADE IN U. S. A.

1111 FLUXGATE MAGNETOMETER SETUP DISPLAY (DEFAULT VALUES)

ERROR MSG:

ORIGINAL PAGE IS OF POOR QUALITY

0: PROCEDURE & ENTRY INSTRUCTIONS UP TO FLUXGATE MAGNETOMETER SETUP DISPLAY ____ UP/I/D

1: MAGNETOMETER ON ON/OFF

READY

2: SPARE

COIL BIAS, SCALE FACTOR, BANDPASS

3: SPARE

4: SPARE

5: SPARE

6: SPARE

7: SPARE

8: SPARE

9: SPARE

10: SPARE

11: SPARE

12: SPARE

13: SPARE

14: SPARE

15: TAKE DATA 10 TIMES PER CYCLE

16: AVERAGE OVER 1 CYCLES

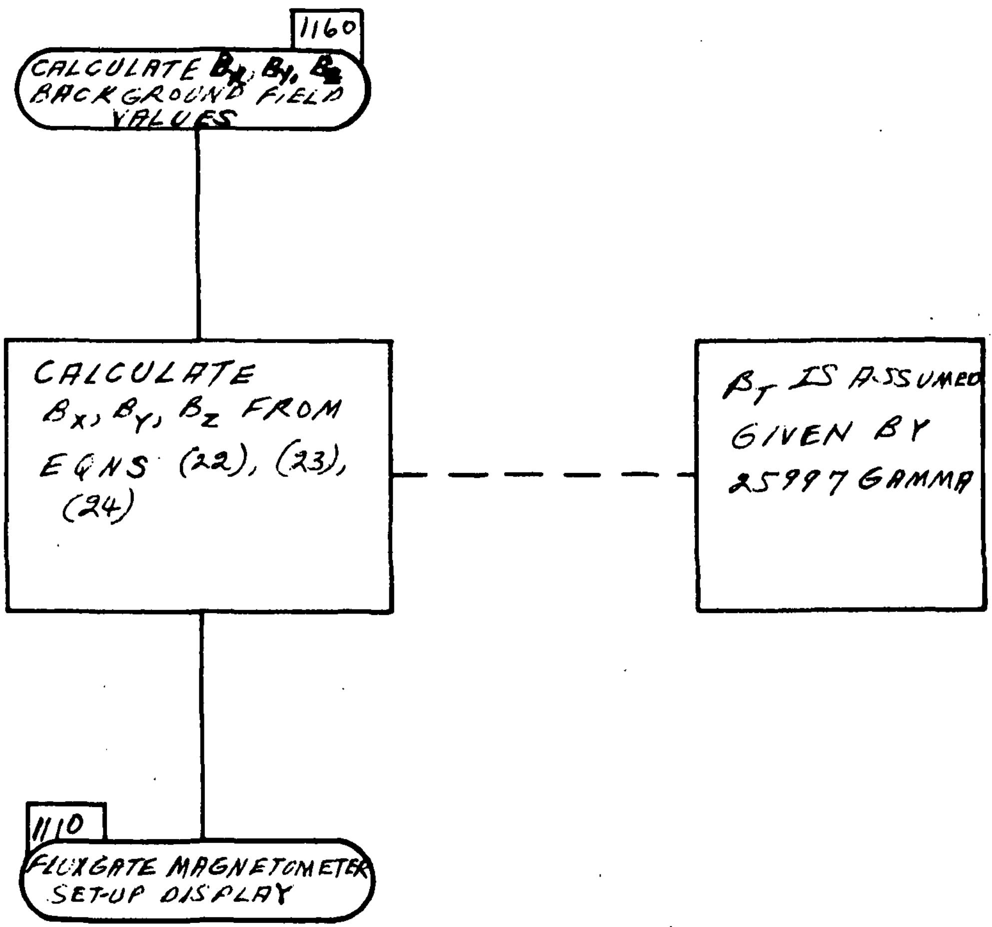
17: BACKGROUND MEASUREMENTS GO GO/STOP

BACKGROUND B-FIELD VALUES		
BX	0	GAMMA
BY	25997	GAMMA
BZ	0	GAMMA
BTOT	25997	GAMMA
CYCLOTR. FREQ. 840 KHz		

18: RECORD BACKGROUND STOP GO/STOP

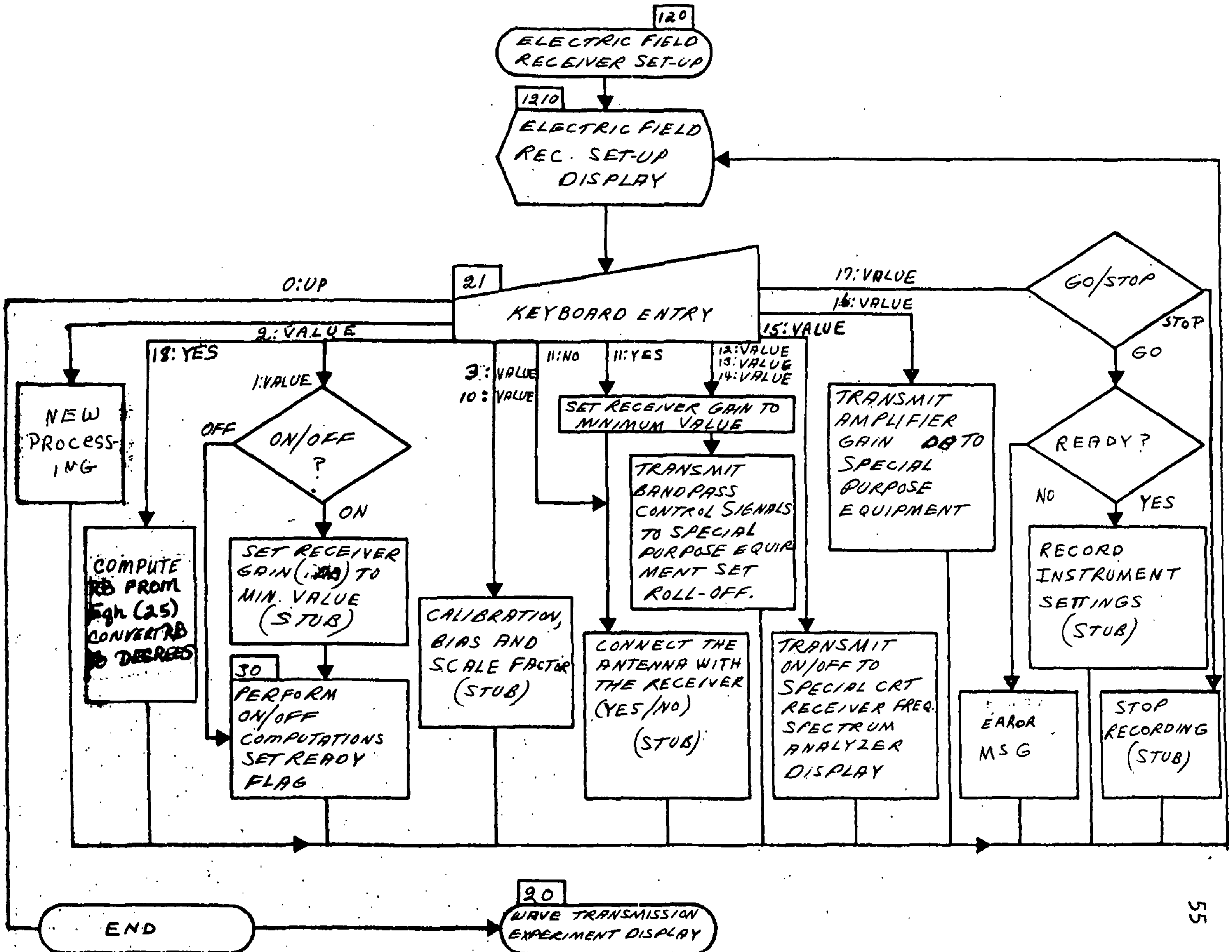
1160 FUNCTIONAL DESCRIPTION

This flowchart shows the processing involved in calculating field measurements in the X, Y and Z coils of the magnetometer, if the B_T vector makes an arbitrary angle to the platform. When Boom A or platform is moved angularly the effect of this rotation will show in the magnetometer components measurements B_X, B_Y, B_Z via the processing defined here.



120 FUNCTIONAL DESCRIPTION

This flowchart shows the processing of the setup of the electric field receiver. Radio-frequency signals are processed in special purpose equipment outside of the computer. The computer, however turns this equipment on and off and protects the receiver against inadvertent damage by setting the gain to a minimum value when it is turned on, connected to the antenna or the receiver frequency is changed. However, this protection is not present when the amplifier gain control is reset by the experimenter. The computer can only record the instrument settings. The computer also can process a derived quantity $\overline{E}^2$. However, this quantity is processed on other flowcharts.



7210 ELECTRIC FIELD RECEIVER
SETUP DISPLAY

ERROR MSG:

C: PROCEDURE & ENTRY INSTRUCTIONS **UP TO WAVE TRANSMISSION EXPERIMENT DISPLAY**	______	UP/I/D
1: RECEIVER	______	ON/OFF
	☐	READY
2: SPARE		
3: CALIBRATION		
4: CALIBRATION		
5: CALIBRATION		
6: BIAS		
7: BIAS		
8: BIAS		
9: SCALE FACTOR		
10: SCALE FACTOR		
11: CONNECT RECEIVER TO ANTENNA	______	YES/NO
12: UPPER FREQUENCY <30 MHz	______	XX.XX MHz
13: LOWER FREQUENCY >3.9 MHz	______	XX.XX MHz
14: ROLLOFF	______	SQU/LIN/EXP
15: SPECIAL CRT RECEIVER OUTPUT DISPLAY	______	ON/OFF
16: SET AMPLIFIER GAIN	______	XX.db 0 TO 80 db
17: RECORD INSTRUMENT SETTINGS AND BACKGROUND	______	GO/STOP
18: DISPLAY ANGLE $\overline{B}_T$ TO DIPOLE ANTENNA AXIS	______	**YES/NO**
RB =	☐	**DEGREES**

1211 ELECTRIC FIELD RECEIVER
SETUP DISPLAY
(DEFAULT VALUES)

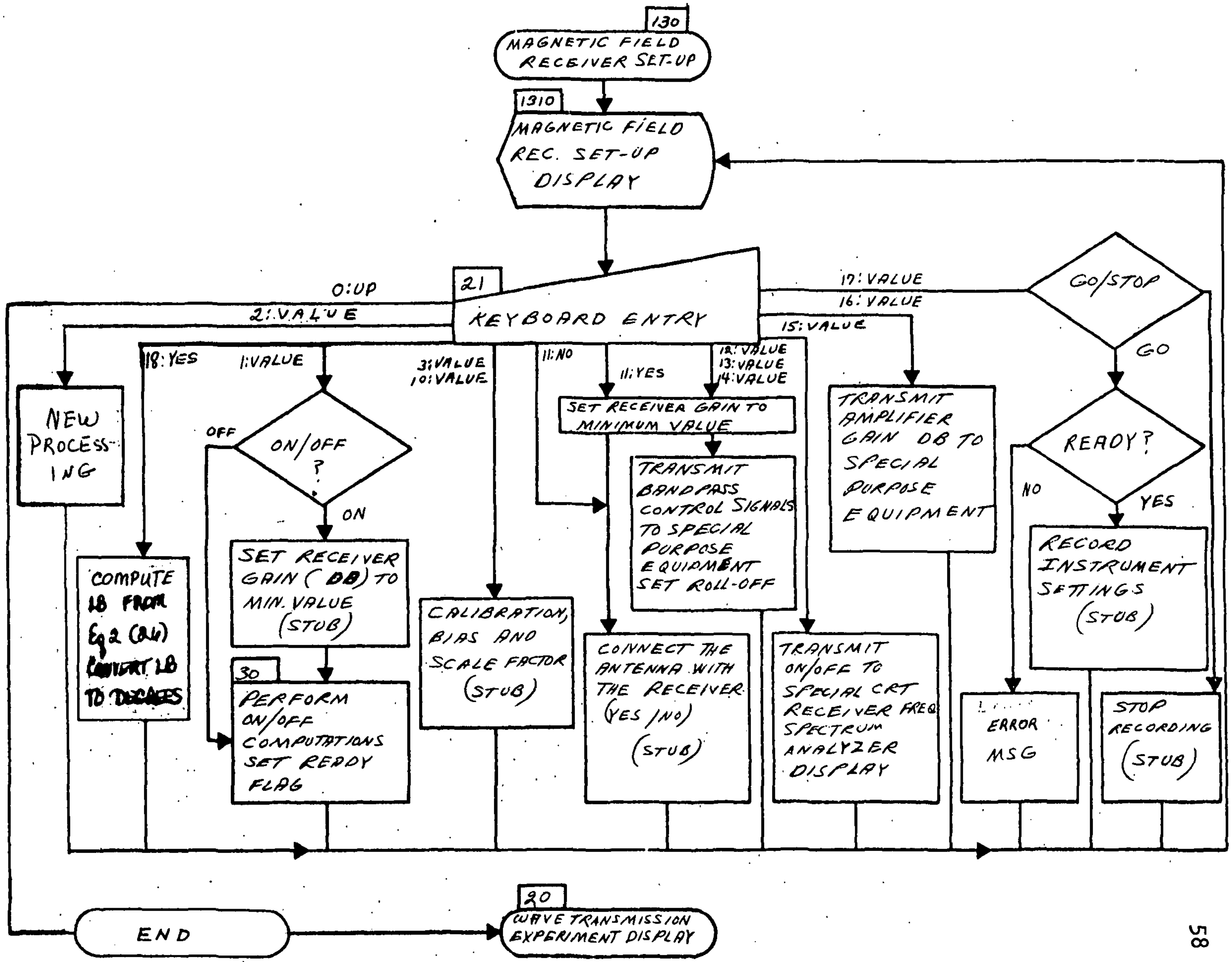
ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS **UP TO ELECTRIC FIELD RECEIVER SETUP DISPLAY**		UP/I/D
1: RECEIVER	**ON**	ON/OFF
		READY
2: SPARE		
3: CALIBRATION		
4: CALIBRATION		
5: CALIBRATION		
6: BIAS		
7: BIAS		
8: BIAS		
9: SCALE FACTOR		
10: SCALE FACTOR		

11: CONNECT RECEIVER TO ANTENNA	**YES**	YES/NO
12: UPPER FREQUENCY <30 MHz	**20.50**	XX.XX MHz
13: LOWER FREQUENCY >3.9 MHz	**3.90**	XX.XX MHz
14: ROLLOFF	**EXP**	SQU/LIN/EXP
15: SPECIAL CRT RECEIVER OUTPUT DISPLAY	**ON**	ON/OFF
16: SET AMPLIFIER GAIN	**40**	XX.db 0 TO 80 db
17: RECORD INSTRUMENT SETTINGS AND BACKGROUND	**STOP**	GO/STOP
18: **DISPLAY ANGLE $\bar{B}_T$ TO DIPOLE ANTENNA AXIS**	**YES**	**YES/NO**
RB =	**0**	**DEGREES**

130 FUNCTIONAL DESCRIPTION

This flowchart shows the processing of the setup of the magnetic field receiver. Radio-frequency signals are processed in special purpose equipment outside of the computer. The computer, however turns this equipment on and off and protects the receiver against inadvertent damage by setting the gain to a minimum value when it is turned on, connected to the antenna, or the receiver frequency is changed. However, this protection is not present when the amplifier gain control is reset by the experimenter. The computer can only record the instrument settings. The computer also can process a derived quantity $\bar{B}^2$. However, this quantity is processed on other flowcharts.



1310 MAGNETIC FIELD RECEIVER
SETUP DISPLAY

ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS ______ UP/I/D
UP TO WAVE TRANSMISSION
EXPERIMENT DISPLAY

1: RECEIVER ______ ON/OFF

READY

2: SPARE

3: CALIBRATION

4: CALIBRATION

5: CALIBRATION

6: BIAS

7: BIAS

8: BIAS

9: SCALE FACTOR

10: SCALE FACTOR

11: CONNECT RECEIVER TO ANTENNA ______ YES/NO

12: UPPER FREQUENCY <30 MHz ______ XX.XX MHz

13: LOWER FREQUENCY >3.9 MHz ______ XX.XX MHz

14: ROLLOFF ______ ______ SQU/LIN/EXP

15: SPECIAL CRT RECEIVER OUTPUT DISPLAY ______ ON/OFF

16: SET AMPLIFIER GAIN ______ XX.db
0 TO 80 db

17: RECORD INSTRUMENT SETTINGS AND BACKGROUND ______ GO/STOP

18: DISPLAY ANGLE B_T TO THE NORMAL TO THE LOOP ANTENNA ______ YES/NO

LB = ______ DEGREES

1311 MAGNETIC FIELD RECEIVER
SETUP DISPLAY
(DEFAULT VALUES)

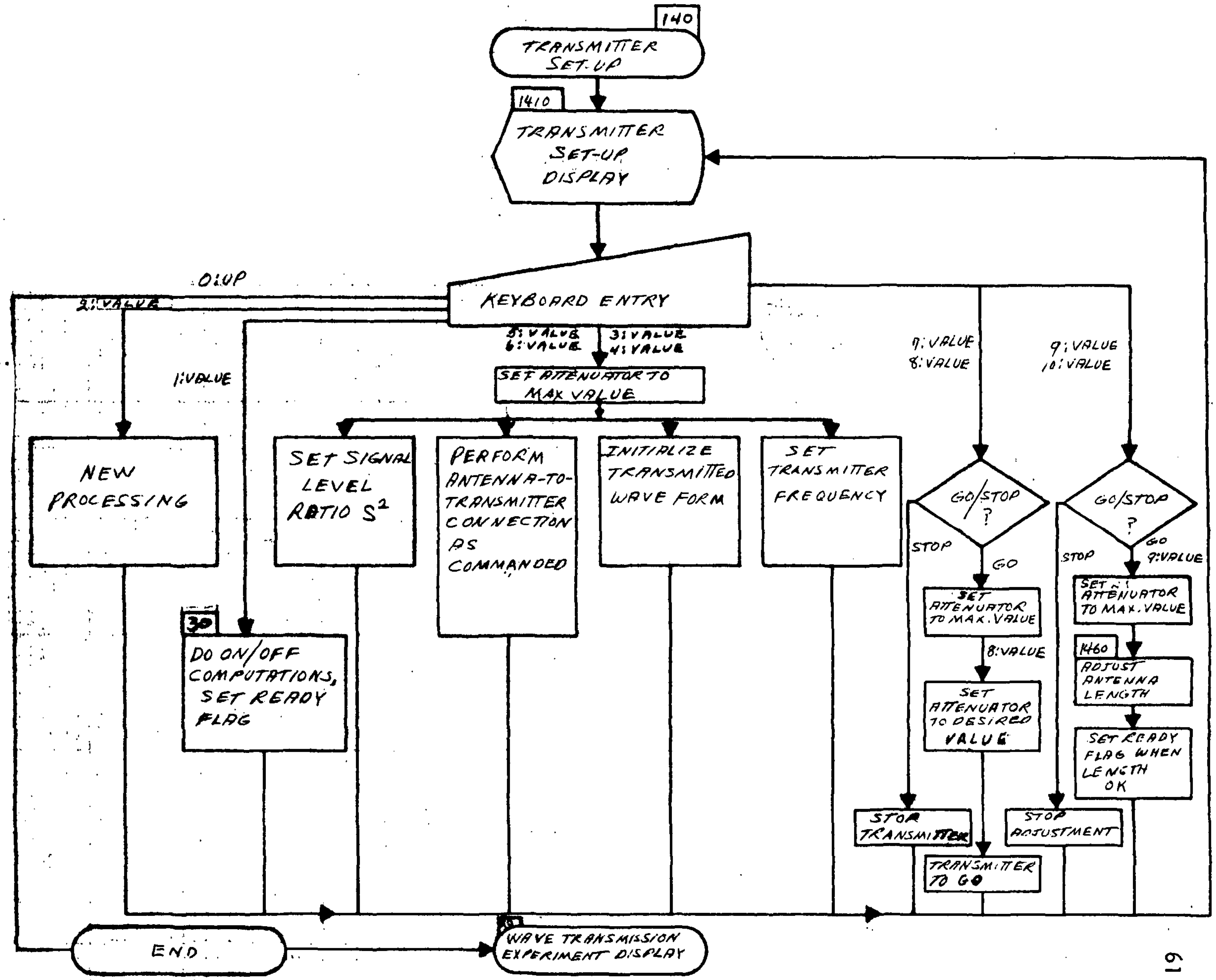
ERROR MSG:

0:	PROCEDURE & ENTRY INSTRUCTIONS **UP TO MAGNETIC FIELD RECEIVER SETUP DISPLAY**		UP/I/D
1:	RECEIVER	**ON**	ON/OFF
			READY
2:	SPARE		
3:	CALIBRATION		
4:	CALIBRATION		
5:	CALIBRATION		
6:	BIAS		
7:	BIAS		
8:	BIAS		
9:	SCALE FACTOR		
10:	SCALE FACTOR		

11:	CONNECT RECEIVER TO ANTENNA	**YES**	YES/NO
12:	UPPER FREQUENCY <30 MHz	**20.50**	XX.XX MHz
13:	LOWER FREQUENCY >3.9 MHz	**3.90**	XX.XX MHz
14:	ROLLOFF	**EXP**	SQU/LIN/EXP
15:	SPECIAL CRT RECEIVER OUTPUT DISPLAY	**ON**	ON/OFF
16:	SET AMPLIFIER GAIN	**40**	XX db 0 TO 80 db
17:	RECORD INSTRUMENT SETTINGS AND BACKGROUND	**STOP**	GO/STOP
18:	**DISPLAY ANGLE $\bar{B}_T$ TO THE NORMAL TO THE LOOP ANTENNA**	**YES**	**YES/NO**
	LB =	90	**DEGREES**

140 FUNCTIONAL DESCRIPTION

This flowchart shows the processing in setting up the transmitter. Whenever a transmitter setting change is made, the attenuator is set to its maximum value to protect other equipment. However, the experimenter can reset the attenuator to a lower attenuation and this reset is not protected. This flowchart also incorporates the adjustment of the (33 meters max.) antenna length which may be connected to the transmitter. In addition to the attenuator, the experimenter can set a signal level ratio ($S^2 \leq 1$) which affects the maximum power that the transmitter is allowed to radiate for this experiment.



1410 TRANSMITTER SETUP DISPLAY

ERROR MSG:

0:	PROCEDURES & ENTRY INSTRUCTIONS	______	UP/I/O
1:	TRANSMITTER	______	ON/OFF
		[ ]	READY
2:	SPARE		
3:	SET SIGNAL LEVEL RATIO S^2	______	X.XX
4:	CONNECT ANTENNA TO TRANSMITTER	______	YES/NO
5:	TRANSMITTER WAVEFORM	______	SIN/SQU/SPECIAL
6:	SET TRANSMITTER FREQUENCY F	______	XX.XX MHz
7:	TRANSMITTER TRANSMISSION	______	GO/STOP
8:	SET TRANSMITTER ATTENUATOR	______	XX 0 TO 80 db
9:	SET WAVE GENERATOR ANTENNA LENGTH	______	XX.X METERS
10:	**ANTENNA LENGTH**	______	GO/STOP

ANTENNA [ ] READY

[41] TRANSMITTER SETUP DISPLAY

(DEFAULT VALUES)

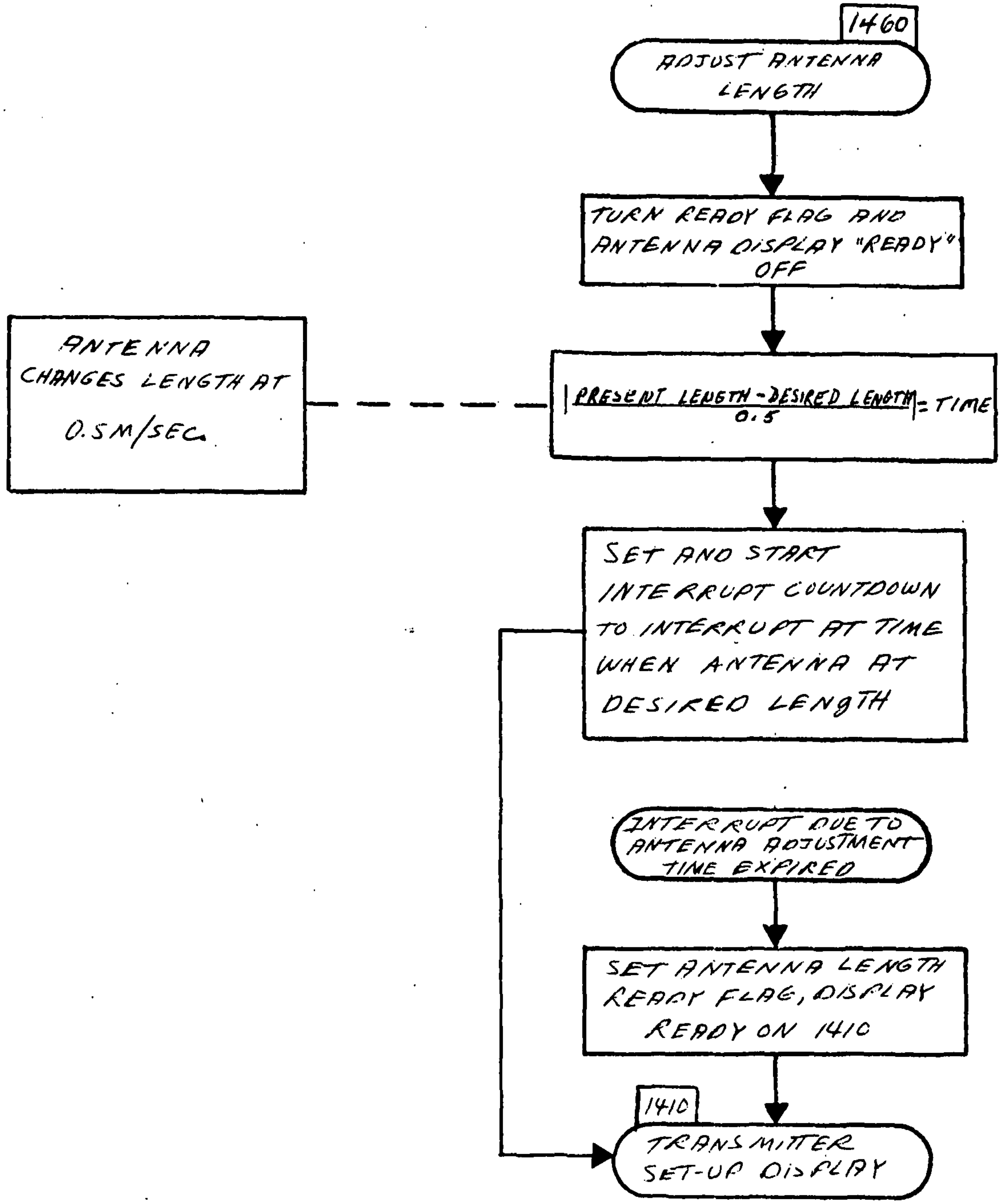
ERROR MSG:

0:	PROCEDURES & ENTRY INSTRUCTIONS		UP/I/D
1:	TRANSMITTER	**ON**	ON/OFF
			READY
2:	SPARE		
3:	SET SIGNAL LEVEL RATIO S^2	**1.00**	X.XX
4:	CONNECT ANTENNA TO TRANSMITTER	**YES**	YES/NO
5:	~~TRANSMITTER WAVEFORM~~	**SIN**	SIN/SQU/SPECIAL
6:	SET TRANSMITTER FREQUENCY f	**19.60**	XX.XX MHz
7:	TRANSMITTER TRANSMISSION	**GO**	GO/STOP
8:	SET TRANSMITTER ATTENUATOR	**80**	XX 0 TO 80 db
9:	SET WAVE GENERATOR ANTENNA LENGTH	**6.0**	XX.X **METERS**
10:	**ADJUST ANTENNA LENGTH**	**GO**	GO/STOP

READY

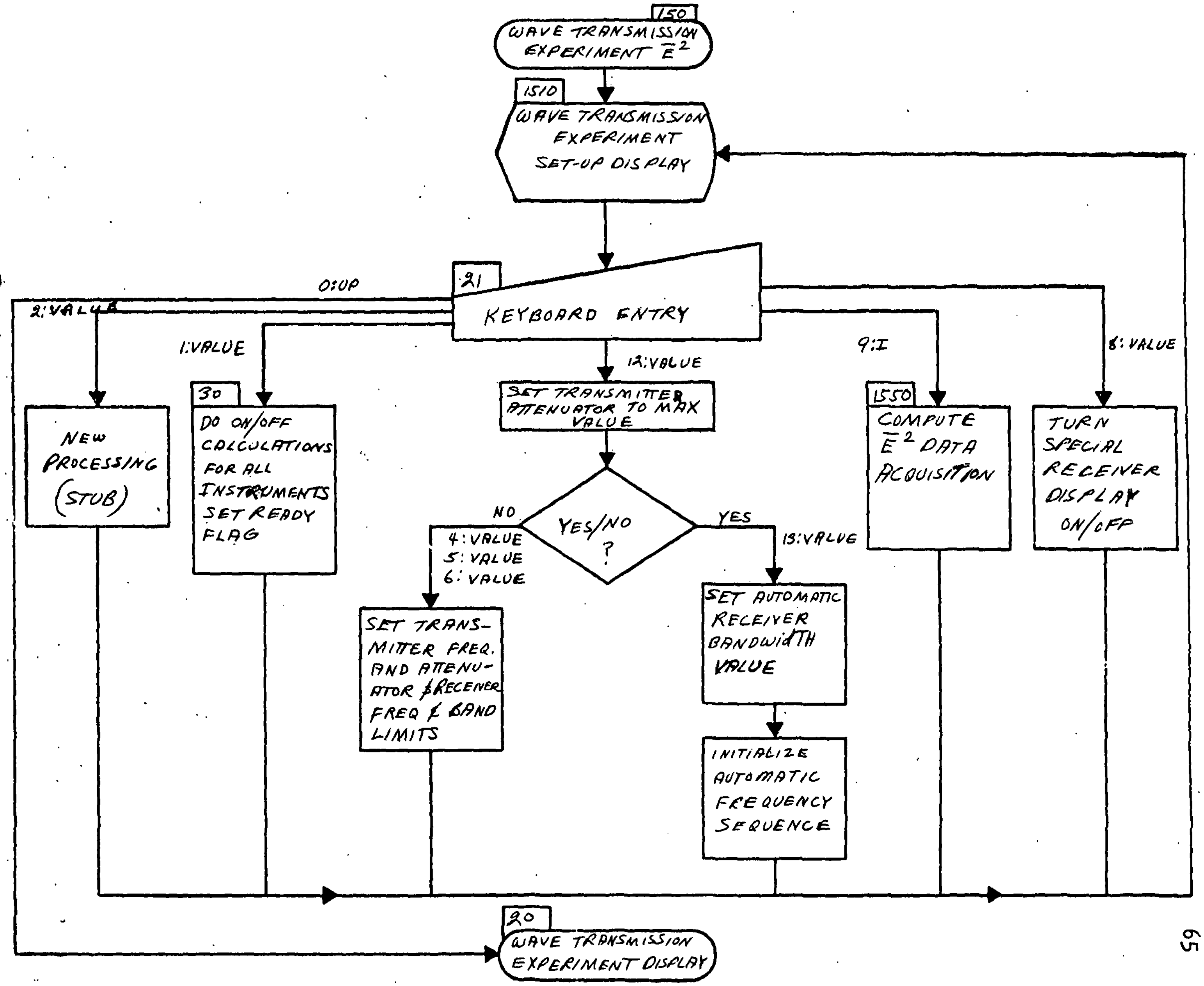
1460 FUNCTIONAL DESCRIPTION

This flowchart shows the processing to adjust the antenna length to a new value. The interrupt when the antenna is ready can have a low priority, since a few seconds more on antenna length readiness will not significantly influence the experiment operation.



150 FUNCTIONAL DESCRIPTION

This flowchart shows the processing especially adapted to rapid performance of the Wave Transmission experiment. Instead of separately setting up transmitter and receiver, they are adjusted here with reference to a single display either manually, or via an automatic sequence depending on 12:YES or 12:NO. The processing on this flowchart is experiment specific and is partially redundant with that of previous Transmitter and Receiver setup charts. Infrequently changed settings such as roll-off characteristics must be reset using those setup charts.



15.0 WAVE TRANSMISSION EXPERIMENT E^2
SETUP DISPLAY

ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS ______ UP/I/D

UP TO WAVE TRANSMISSION EXPERIMENT E^2
SETUP DISPLAY

1: ALL EXPERIMENT INSTRUMENTS ______ ON/OFF

[ ] READY

2: SPARE

3: SPARE

MANUAL MODE

4: SET TRANSMITTER FREQUENCY ______ XX.XX MHz

5: SET RECEIVER UPPER FREQUENCY ______ XX.XX MHz

6: SET RECEIVER LOWER FREQUENCY ______ XX.XX MHz

7: SPARE

MANUAL & AUTOMATIC MODE

8: SPECIAL RECEIVER CRT DISPLAY ______ ON/OFF

9: E^2 DATA ACQUISITION DISPLAY ______ I

10: SPARE

11: SPARE

12: AUTOMATIC FREQUENCY SEQUENCE ______ YES/NO

13: AUTOMATIC RECEIVER BANDWIDTH ______ X.XX MHz
FREQUENCY ±

14: SPARE

1511 WAVE TRANSMISSION EXPERIMENT $\bar{E}^2$
SETUP DISPLAY
(DEFAULT VALUES)

ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS ____ UP/I/D

UP TO WAVE TRANSMISSION EXPERIMENT $\bar{E}^2$
SETUP DISPLAY

1: ALL EXPERIMENT INSTRUMENTS **ON** ON/OFF

[ ] READY

2: SPARE

3: SPARE

MANUAL MODE

4: SET TRANSMITTER FREQUENCY **19.60** XX.XX MHz

5: SET RECEIVER UPPER FREQUENCY **19.61** XX.XX MHz

6: SET RECEIVER LOWER FREQUENCY **19.59** XX.XX MHz

7: SPARE

MANUAL & AUTOMATIC MODE

8: SPECIAL RECEIVER CRT DISPLAY **ON** ON/OFF

9: $\bar{E}^2$ DATA ACQUISITION DISPLAY **I** I

10: SPARE

11: SPARE

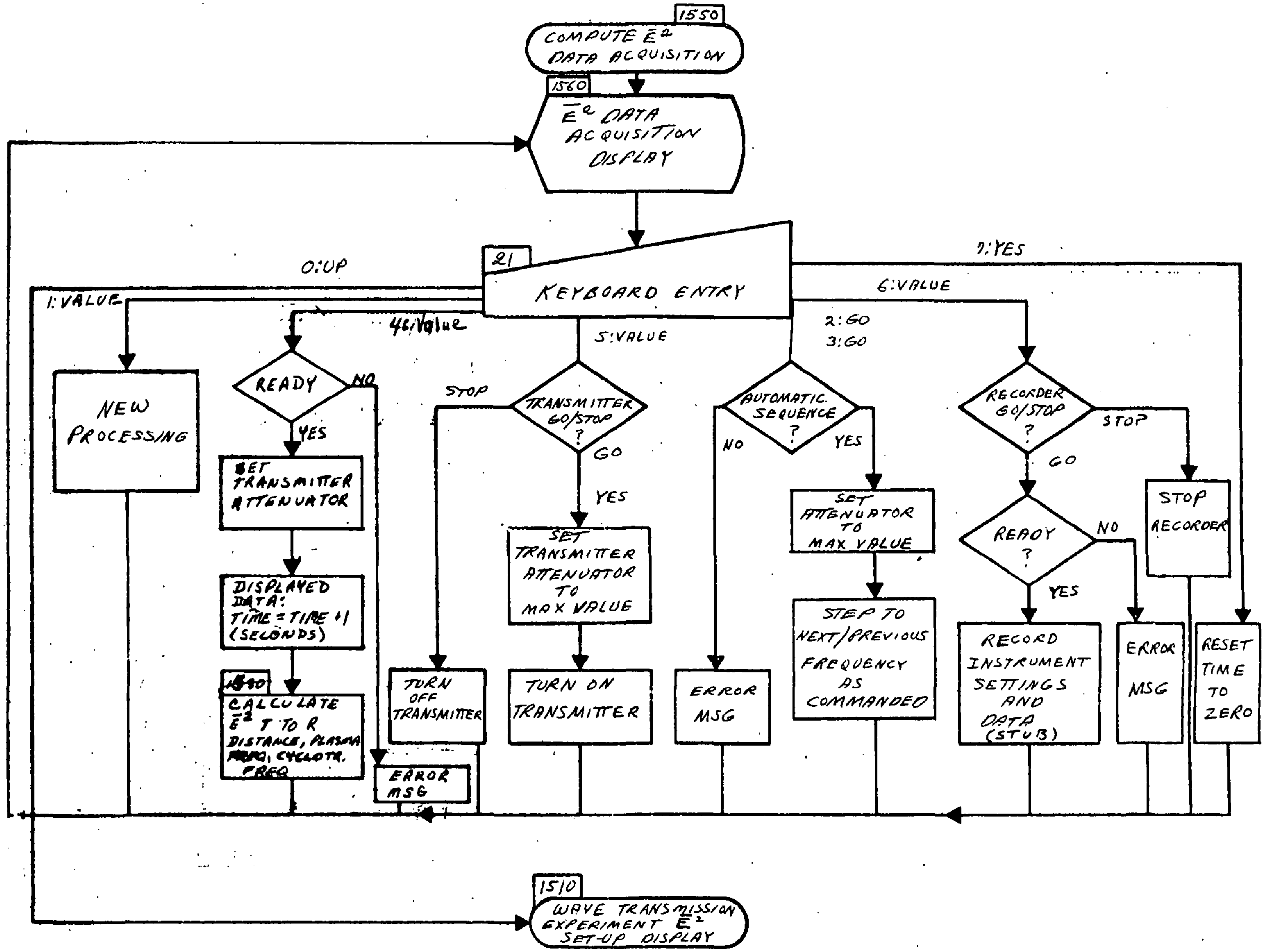
12: AUTOMATIC FREQUENCY SEQUENCE **YES** YES/NO

13: AUTOMATIC RECEIVER BANDWIDTH FREQUENCY ± **0.01** X.XX MHz

14: SPARE

1550 FUNCTIONAL DESCRIPTION

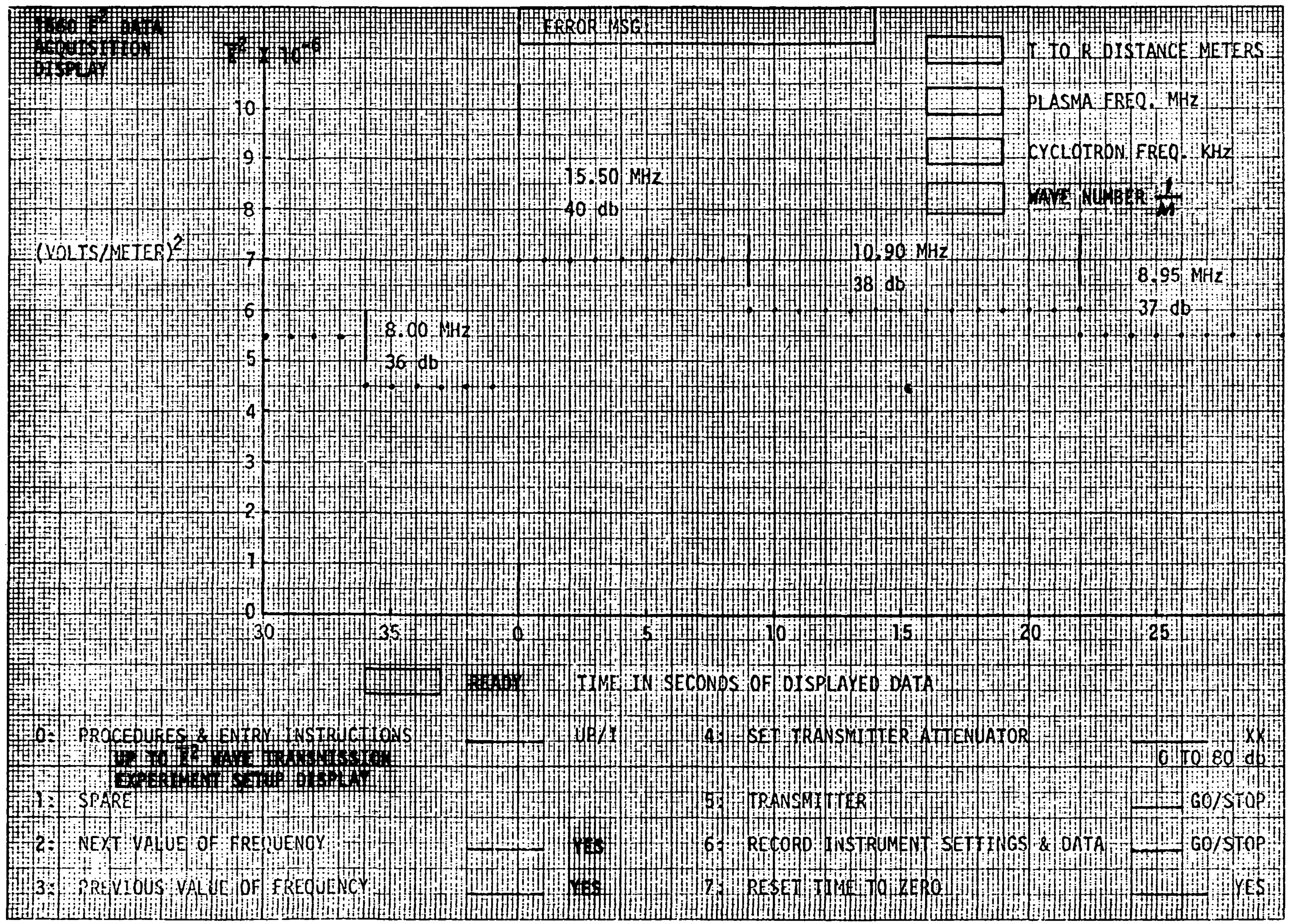
This flowchart shows the processing of the mean square electric field values received by the computer. If the computer is in the automatic (frequency sequencing) mode the planned Wave Transmission experiment sequence can be completed using this flowchart only. If the manual mode is selected, the experimenter must back up to the previous (1510) display to set each new frequency.



NOTE: ROLL-OVER OF DISPLAY
TIME AXIS IS REQUIRED

1560 FUNCTIONAL DESCRIPTION

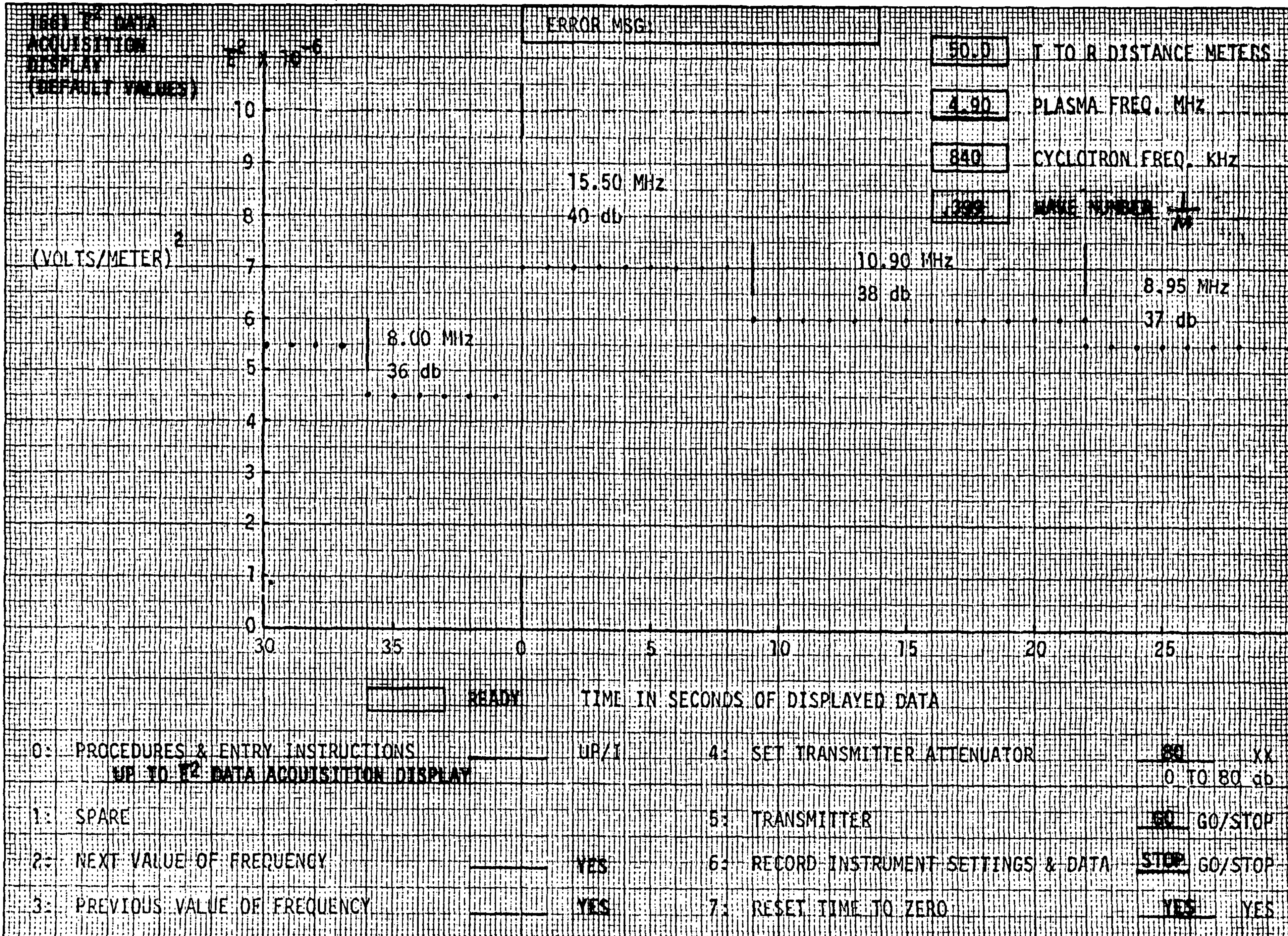
In implementing the display "roll over" of the time axis is required. There are many ways to do this, the important point is that after the first ten seconds of the experiment, there should always be at least ten seconds of data history showing, even if the experiment lasts longer than 40 seconds. The display shown is idealized in that the fall of $\bar{E}^2$ to near-zero when the transmitter attenuator is set to its maximum value when changing frequencies is not shown, nor rise in $\bar{E}^2$ during the resetting of the attenuator by the experimenter.



FOLDOUT FRAME 1

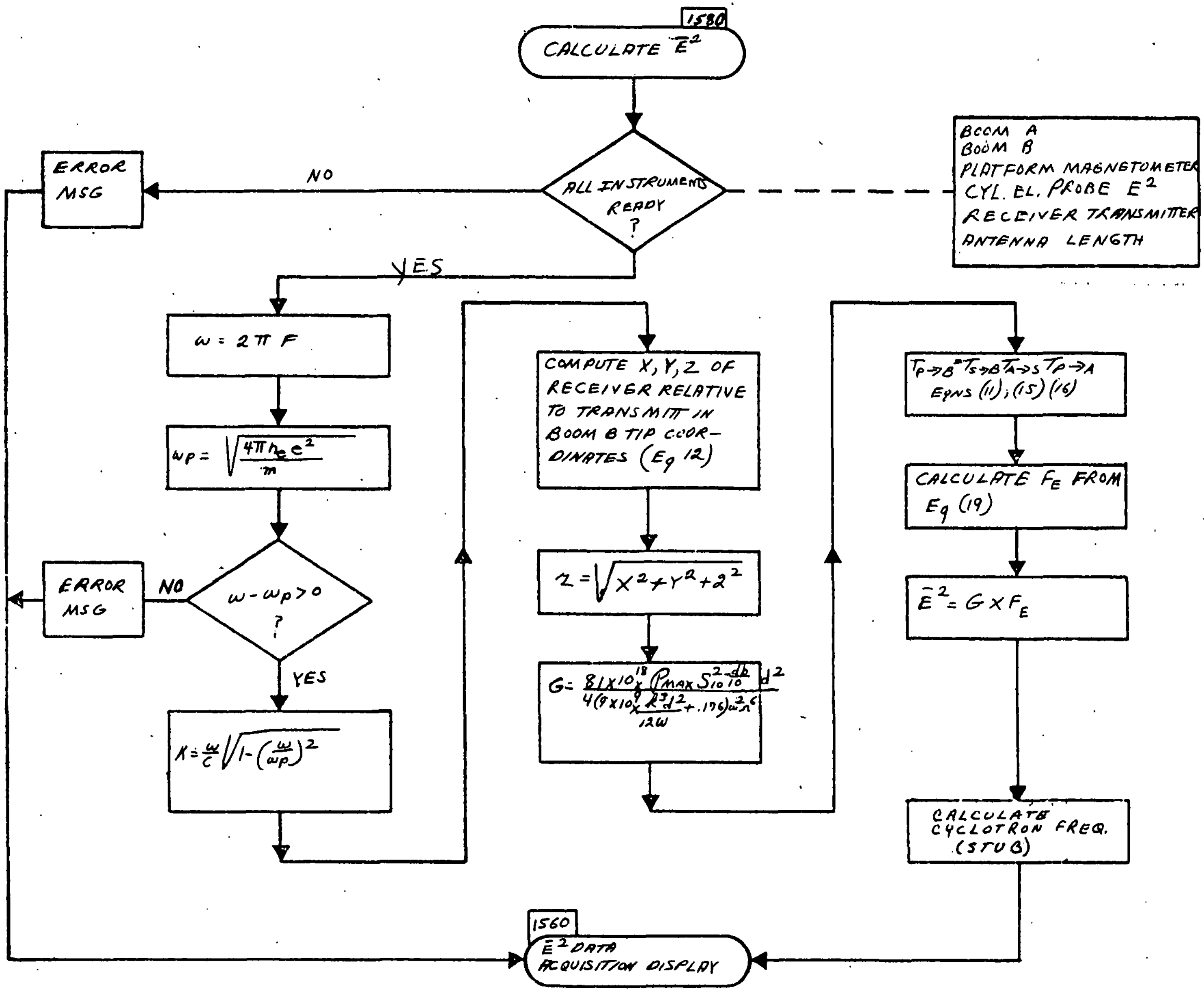
FOLDOUT FRAME 2

NOTE: ROLL-OVER OF DISPLAY
TIME AXIS IS REQUIRED.



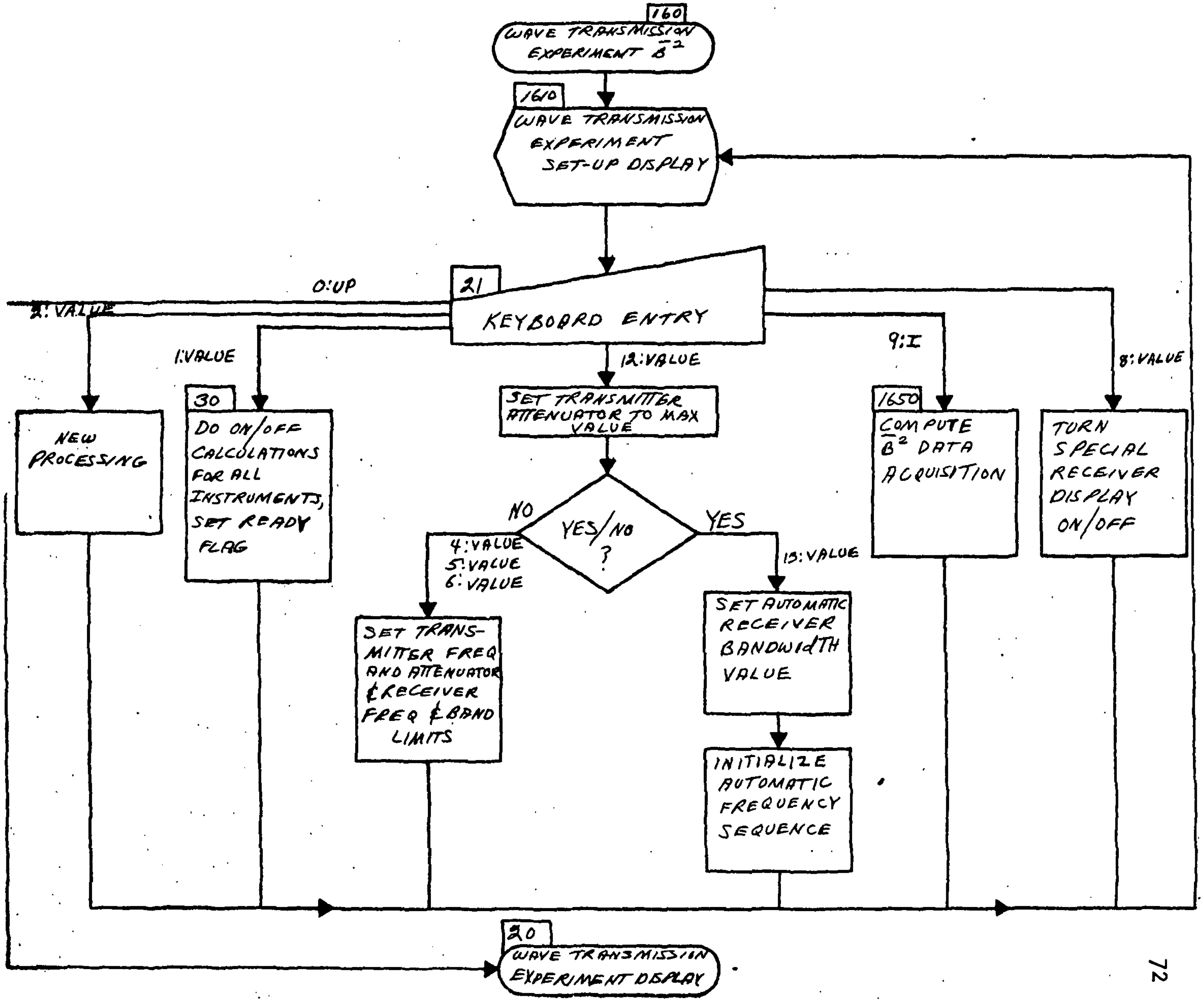
1580 **FUNCTIONAL DESCRIPTION**

This flowchart presents the arithmetic operations involved in calculating $\bar{E}^2$, r, ωp and Cyclotron Frequency (stub) that are displayed on 1560.



160 FUNCTIONAL DESCRIPTION

This flowchart shows the processing especially adapted to rapid performance of the Wave Transmission experiment. Instead of separately setting up transmitter and receiver, they are adjusted here with reference to a single display either manually, or via an automatic sequence depending on 12:YES or 12:NO. The processing on this flowchart is experiment specific and is partially redundant with that of previous Transmitter and Receiver setup charts. Infrequently changed settings such as roll-off characteristics must be reset using those setup charts.



16.0 WAVE TRANSMISSION EXPERIMENT $\overline{B}^2$
SETUP DISPLAY

ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS ______ UP/I/D

UP TO WAVE TRANSMISSION EXPERIMENT $\overline{B}^2$
SETUP DISPLAY

1: ALL EXPERIMENT INSTRUMENTS ______ ON/OFF

READY

2: SPARE

3: SPARE

MANUAL MODE

4: SET TRANSMITTER FREQUENCY ______XX.XX MHz

5: SET RECEIVER UPPER FREQUENCY ______XX.XX MHz

6: SET RECEIVER LOWER FREQUENCY ______XX.XX MHz

7: SPARE

MANUAL & AUTOMATIC MODE

8: SPECIAL RECEIVER CRT DISPLAY ______ ON/OFF

9: $\overline{B}^2$ DATA ACQUISITION DISPLAY ______ I

10: SPARE

11: SPARE

12: AUTOMATIC FREQUENCY SEQUENCE ______ YES/NO

13: AUTOMATIC RECEIVER BANDWIDTH ______X.XX MHz
FREQUENCY ±

14: SPARE

161 WAVE TRANSMISSION EXPERIMENT $\overline{B}^2$
SETUP DISPLAY
(DEFAULT VALUES)

ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS UP/I/D

UP TO WAVE TRANSMISSION EXPERIMENT $\overline{B}^2$
SETUP DISPLAY

1: ALL EXPERIMENT INSTRUMENTS **ON** ON/OFF

READY

2: SPARE

3: SPARE

MANUAL MODE

4: SET TRANSMITTER FREQUENCY **19.60** XX.XX MHz

5: SET RECEIVER UPPER FREQUENCY **19.61** XX.XX MHz

6: SET RECEIVER LOWER FREQUENCY **19.59** XX.XX MHz

7: SPARE

MANUAL & AUTOMATIC MODE

8: SPECIAL RECEIVER CRT DISPLAY **ON** ON/OFF

9: $\overline{B}^2$ DATA ACQUISITION DISPLAY **I** I

10: SPARE

11: SPARE

12: AUTOMATIC FREQUENCY SEQUENCE **YES** YES/NO

13: AUTOMATIC RECEIVER BANDWIDTH FREQUENCY ± **0.01** X.XX MHz

14: SPARE

16) WAVE TRANSMISSION EXPERIMENT B^2
SETUP DISPLAY
(DEFAULT VALUES)

ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS ______ UP/I/D
UP TO WAVE TRANSMISSION EXPERIMENT $\overline{B}^2$
SETUP DISPLAY

1: ALL EXPERIMENT INSTRUMENTS **ON** ON/OFF

[I] READY

2: SPARE

3: SPARE

MANUAL MODE

4: SET TRANSMITTER FREQUENCY **19.60** XX.XX MHz

5: SET RECEIVER UPPER FREQUENCY **19.61** XX.XX MHz

6: SET RECEIVER LOWER FREQUENCY **19.59** XX.XX MHz

7: SPARE

MANUAL & AUTOMATIC MODE

8: SPECIAL RECEIVER CRT DISPLAY **ON** ON/OFF

9: $\overline{B}^2$ DATA ACQUISITION DISPLAY **I** I

10: SPARE

11: SPARE

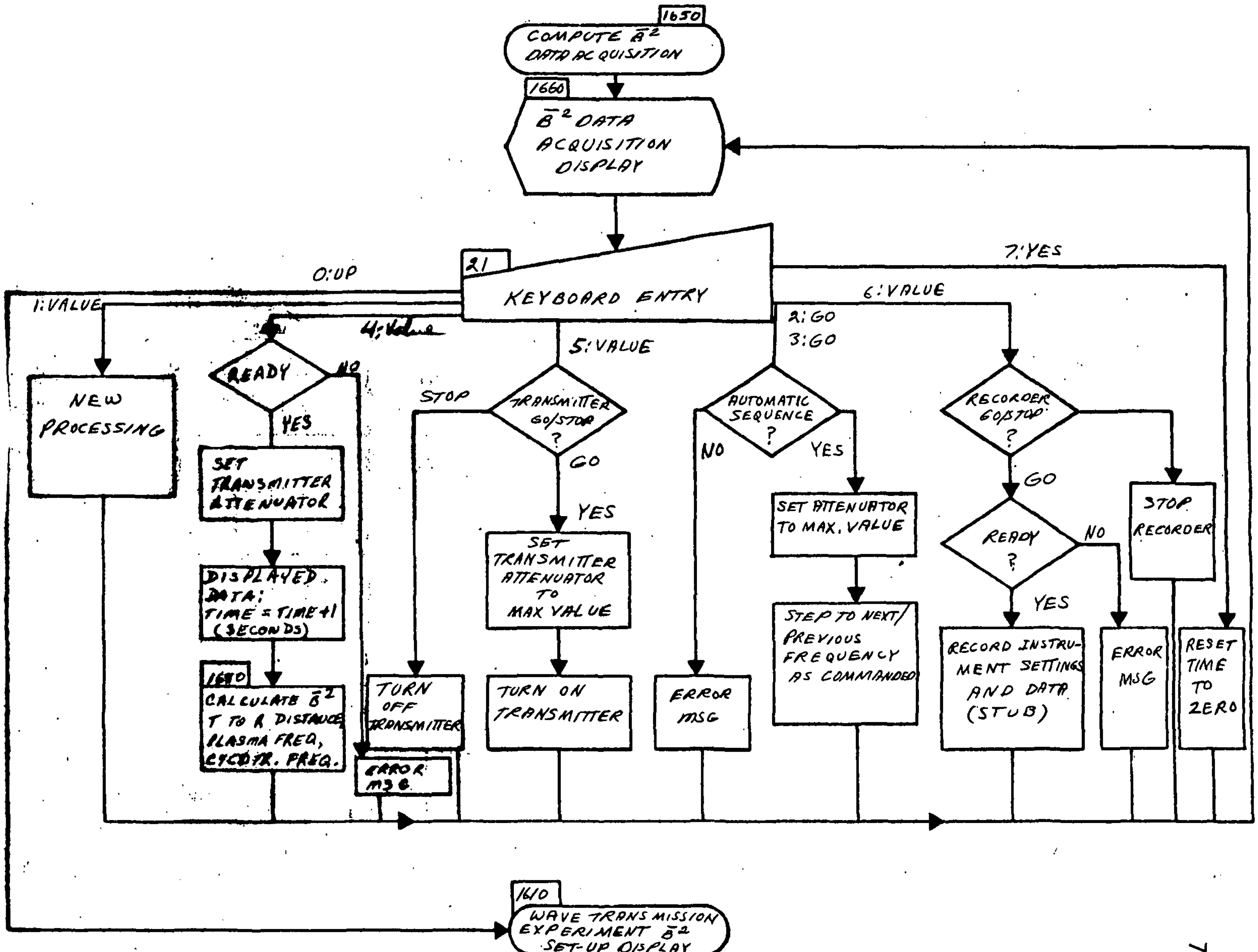
12: AUTOMATIC FREQUENCY SEQUENCE **YES** YES/NO

13: AUTOMATIC RECEIVER BANDWIDTH FREQUENCY ± **0.01** X.XX MHz

14: SPARE

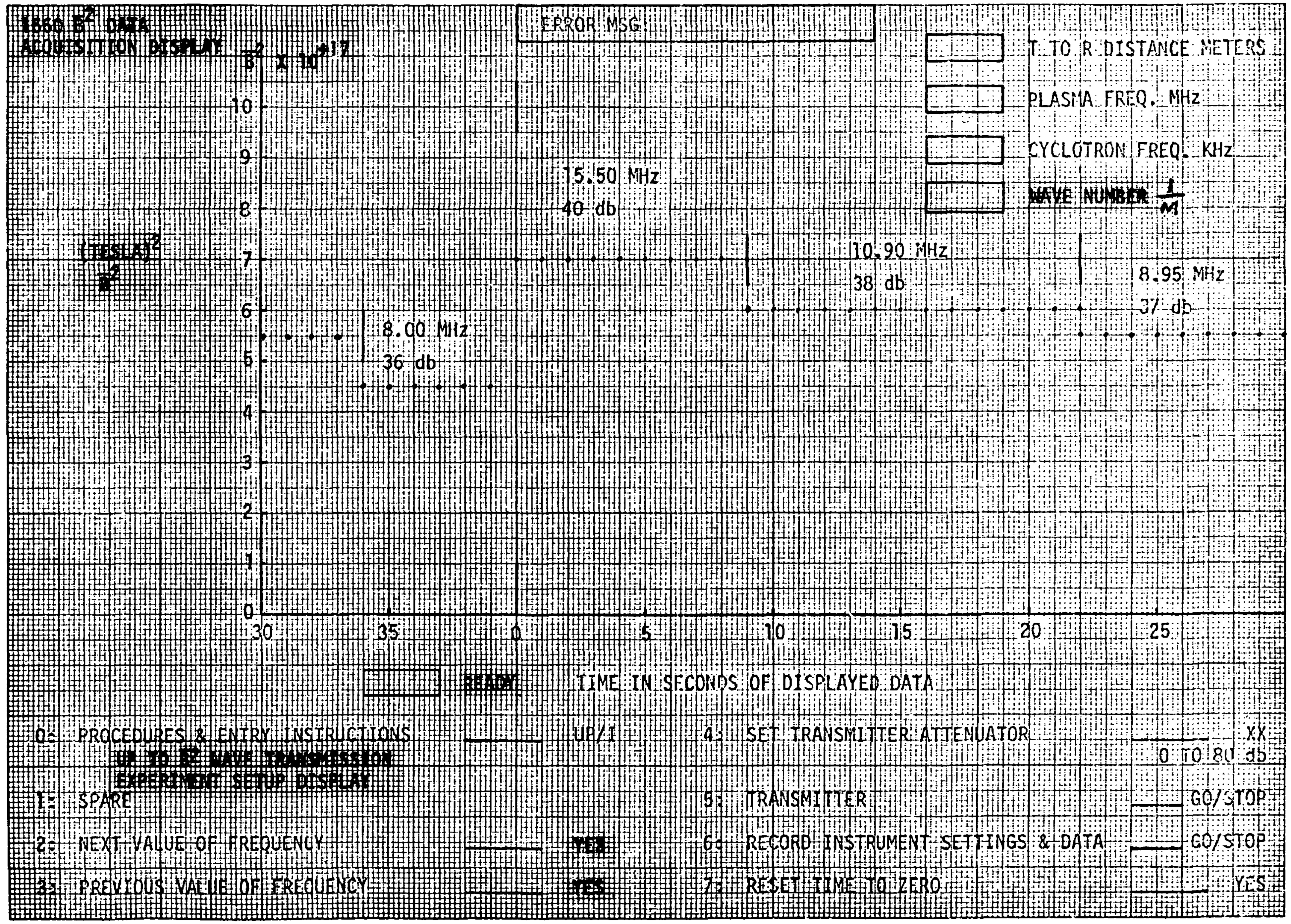
1650 FUNCTIONAL DESCRIPTION

This flowchart shows the processing of the mean square magnetic field values received by the computer. If the computer is in the automatic (frequency sequencing) mode the planned Wave Transmission experiment sequence can be completed using this flowchart only. If the manual mode is selected, the experimenter must back up to the previous (1610) display to set each new frequency.

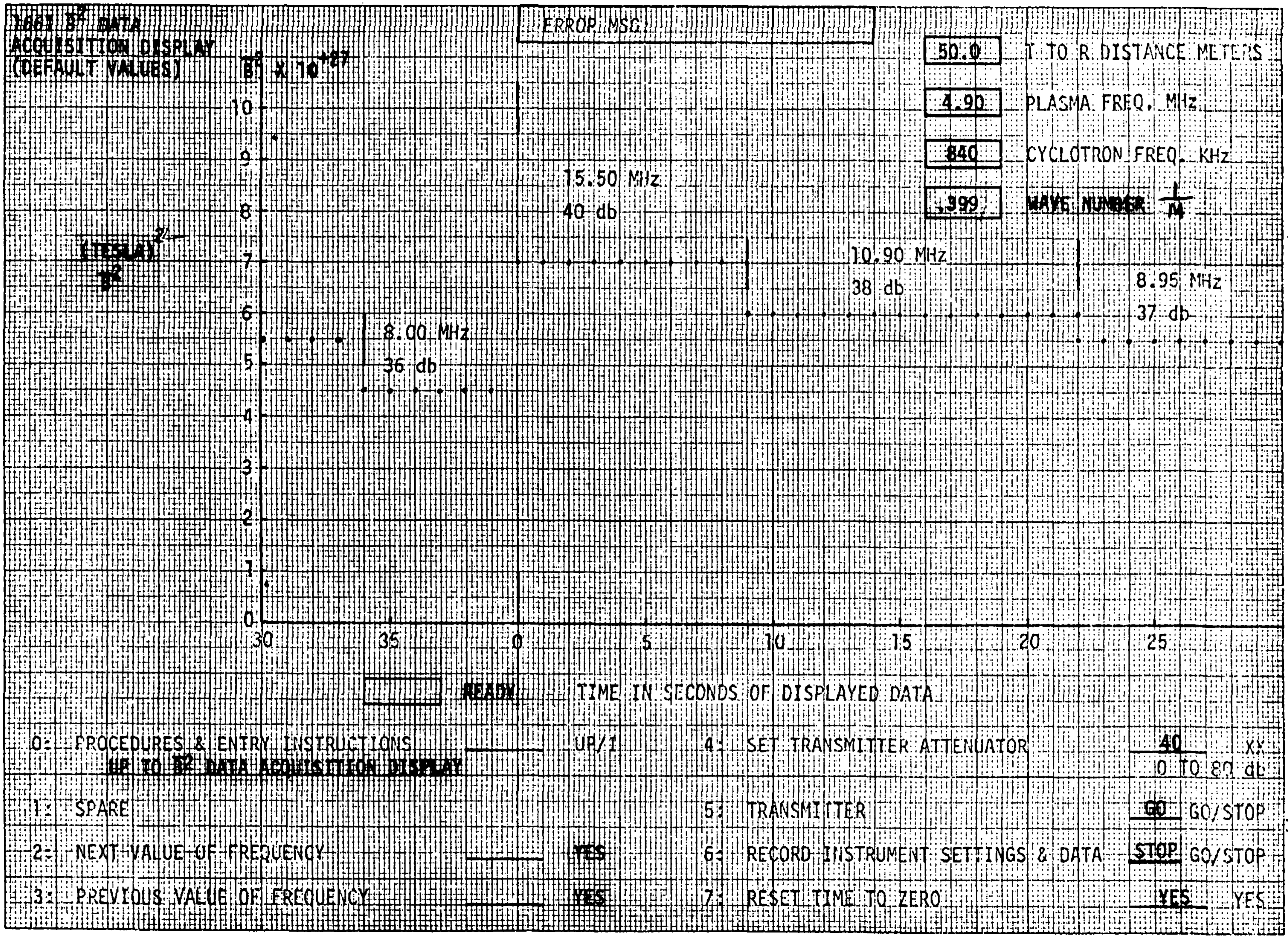


1660 FUNCTIONAL DESCRIPTION

In implementing the display, "roll over" of the time axis is required. There are many ways to do this, the important point is that after the first ten seconds of the experiment, there should always be at least ten seconds of data history showing, even if the experiment lasts longer than 40 seconds. The display 1661 shown is idealized in that the temporary fall of $\overline{B}^2$ to near zero when the transmitter attenuator is set to its maximum value when changing frequencies is not shown, nor the rise in $\overline{B}^2$ during the resetting of the attenuator by the experimenter.

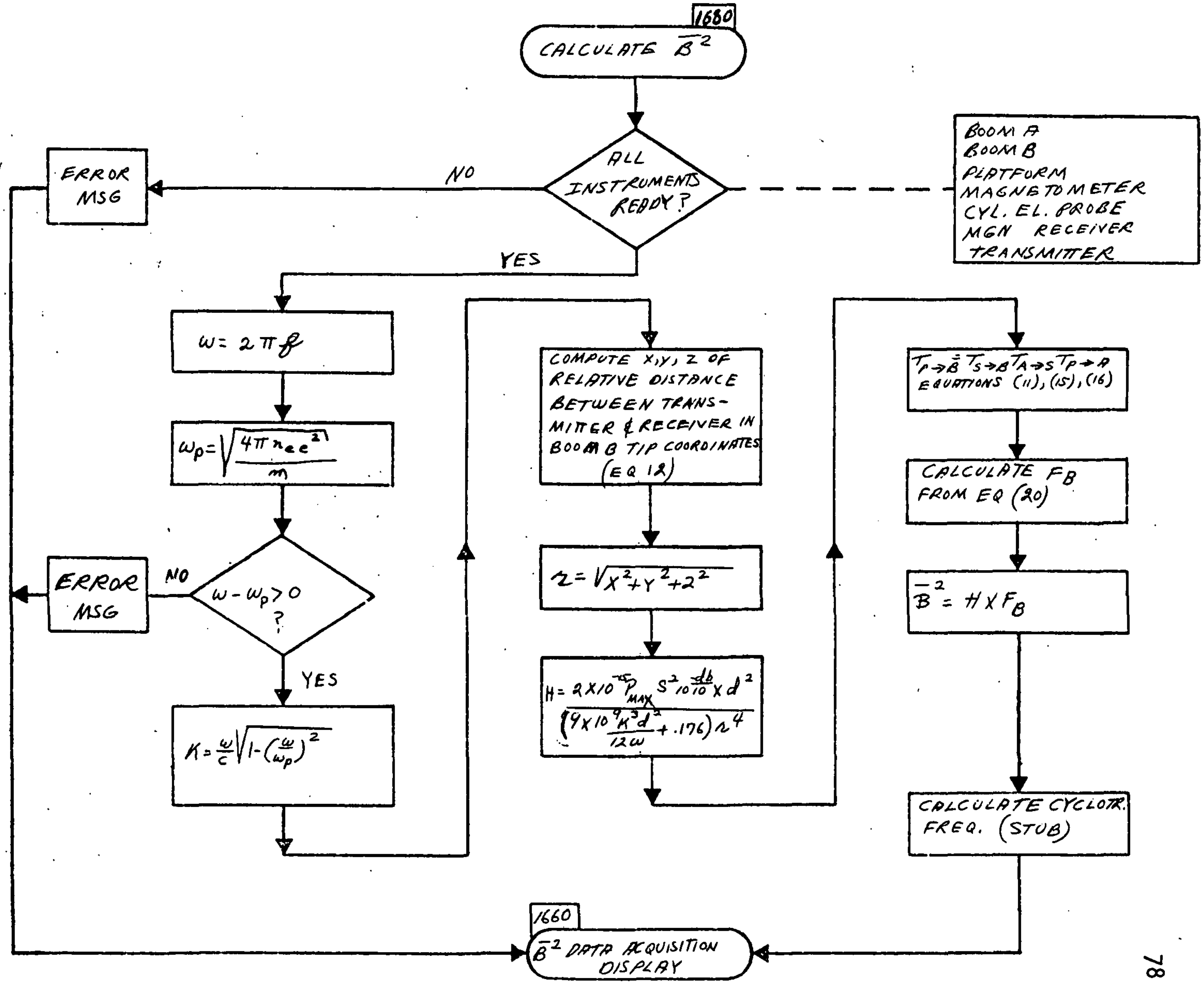


NOTE: ROLL-OVER OF DISPLAY
TIME AXIS IS REQUIRED



1680 FUNCTIONAL DESCRIPTION

This flowchart presents the arithmetic operations involved in calculating $\overline{B}^2$, r, ωp and Cyclotron Frequency (stub) that are displayed on 1660.



6.2 PASSIVE OBSERVATIONS OF AMBIENT PLASMA EXPERIMENT

(The experiment procedure for this experiment is given in Section 3.2.2 of the Final Report.)

The key dispaly of this experiment is Display No. 200, where the experimenter chooses the instruments he wishes to use in order to observe the plasma. Via Entry No. 3: he can initialize his orbit, which for this set of experiments is always circular. Once started, the orbit computation continues to compute needed orbital quantities every two seconds whether these are used by the experiments or not. If the experimenter wishes to see where the orbiter is, he will enter 4:1 which will bring Display 500 with complete information on the latest orbit update. Time is assumed displayed separately on a non-CRT (TDU) display.

The capability to activate all instruments is given to the experimenter by Entry No. 1:. He can manipulate the individual instrument settings via Entry No's. 8 and 9 for the cylindrical electron probe and fluxgate magnetometer, and via Entry No's. 13: through 18: for the other instruments. Entry No. 19:gives him the capability to selectively record the outputs of only those instruments data that are worth preserving. The mere fact that an instrument is on does not force the experimenter to record the data produced. The experimenter can also limit the time duration of recordings produced.

Entry No's. 10: and 11: show summary displays to the experimenter. Display 280 (Entry 10:1) shows both orbital and boom/platform summary data. Display 290 (Entry 11:1) shows summary data on the outputs of several instruments participating in this experiment and may be considered experiment specific. Note that there is physical area on this display to accomodate additional instrument outputs should this be needed, without requiring substantial additional software, since the quantities themselves that are displayed are easily available from the available individual instrument computational routines.

6.2.1 Definition of Variables

The following definitions define variables used in the flowcharting that follows. For a more comprehensive understanding of the equations involved see the main body of the Final Report.

LTo Local time at the first descending node. $0 \leq LTo < 24$ HRS., keyed in HRS:MINS:SECS. on the keyboard (or initialized in the TDU) Days are not considered in this simulation.

GmTo Greenwich Mean Time at the instant of descending node crossing of the Orbiter. Keyed in HRS:MINS:SEC. on the keyboard (or initialized in the TDU) $0 \leq GmTo < 24$ HRS.

MET_i Mission Elapsed Time. Time since passage of the first descending node at the start of the simulation run keyed in HRS:MINS:SECS. on the keyboard (or initialized in the TDU).

τ Time incrementing variable in seconds.

LToH LTo expressed in decimal hours.

UToH GmTo expressed in decimal hours.

OTS_i MET_i expressed in seconds.

t Time in seconds = OTS_i + duration of simulation run.

UToS Initial value of GMTo expressed in seconds.

UTS Current value of GMT in seconds.

R Geocentric radius of the Orbiter, in meters. $R=(Re+H) \times 1000$.

R_e Radius of the spherical earth, 6371 KM

H Altitude of Orbiter above spherical earth, KM. Typical values: $120 \leq H \leq 400$.

LON East longitude of the Orbiter with respect to Greenwich Meridian, degrees.

LAT South latitude of Orbiter, degrees.

LT Local Time of the Orbiter (or any other object referred to), as given by the position of the sun at that location (LT in decimal HRS for computation, HRS:MINS for display). Local time is 12:00 (noon) if the sun is in the half-plane containing the earth polar axis as boundary and the Orbiter geocentric radius.

Λ	Euler angle between the local vertical + Z^{I} axis and the Orbiter + Z axis $0^{o} \leq \Lambda \leq 180^{o}$, degrees measured positive from + Z^{I}.
Γ	Euler angle between the vector pointing south in the horizontal plane at the Orbiter and the positive line of nodes of the Orbiter Λ Γ Δ system. $0^{o} \leq \Gamma < 360^{o}$, degrees measured positive from + X rotating to + Y. See part III diagram of axis.
Δ	Euler angle between line of nodes and Orbiter + X axis $0^{o} \leq \Delta < 360^{o}$.
T Orbit	Orbiter orbital period, seconds.
i	Inclination angle of orbit plane to earths equatorial plane, degrees $0 \leq i \leq 90^{o}$. For a polar orbit $i = 90^{o}$.
w	Rate of rotation of Orbiter geocentric vector relative to an inertial coordinate frame in the plane of the orbit, in radians/sec.
λ	Angle between earth's north polar axis and orbiter geocentric radius vector measured sourthward from north polar axis. $0^{o} \leq \lambda \leq 180^{o}$.
Magnetic Dip Angle	Angle between local geocentric radius vector and local earth magnectic field vector, radians (displayed in degrees).
$\lvert B_T \rvert$	Magnitude of earth's magnetic field vector, gammas. Range 0 to 10^{5} gammas, least count one gamma.
T	Neutral atmosphere temperature, degrees Kelvin Range 10^{2} to 10^{4}. Least count 0.1% of value.
$N(O_2+)$, $N(NO+)$, $N(O+)$	The number of free ions per cubic meter Range: 10^{6} to 10^{12}. Least count 1% of value.

n(LT)	The number of free electrons per cubic meter, expressed as a function of local time. n(LT) is also a function of other variables. Range 10^6 to 10^{14} least count 1% of value. Also used for total ion density in neutral atmosphere.
P	Probe voltage in volts. Range -10^4 to $+10^4$ volts. Least count 0.1% of value.
Ie^+(or Ie^-)	Current due to electrons flowing into probe when probe voltage positive (or negative).
Ii^-(or Ii^+)	Current due to ions flowing into probe when probe voltage is negative (or positive).
$\overline{V}$, $\overline{V}s$	Orbiter velocity vector, meters/secs, Orbiter velocity = ωR meters/sec.
CSV	Angle between the probe axis of the cylindrical Electron Probe and the Orbiter velocity vector.
Mi	The mass of a particular ion species, i, measured in kilograms. Range 10^{-27} to 10^{-25} kg. Least count 0.1% of value.
Ve	The velocity of a particle involved in probe measurement, relative to a quasi-inertial Orbiter coordinate system in which $\overline{V}_s$ is also measured. Range $\pm 10^4$ meters/sec. Least count one M/sec.
Lower to Upper Mass Limits	One to forty Atomic Mass Units (AMU).
X'Y'Z'	Quasi-inertial orbiter-centered cartesian coordinate system. Z' outward along geocentric radius, +X' points South, +Y' points East.

6.2.2 Typical Values for Passive Observations of Ambient Plasma Experiment Parameters

The following parameter values may be considered as typical. They could, for example, be used as default values. Additional values have been inserted on several graphical displays for illustrative purposes.

<u>Orbiter attitude</u>

Λ = 0 Degrees
Γ = 0 Degrees
Δ = 0 Degrees

<u>Boom A</u>

θ = 0 Degrees
ϕ = 0 Degrees
L_A 0 Degrees

<u>Platform</u>

Ω = 0 Degrees
χ = 0 Degrees
ψ = 0 Degrees

Angle platform X_1 to Orbiter $\overline{V}$ = 0 Degrees

Inclination of Orbit Plane = 57 Degrees

Altitude H = 300 KM
$|B_T|$ = 27183 GAMMA.

<u>Densities of Ions</u>

N(O+) = 4.6 E 11
N(O2+) = 2.9 E 10
N(NO+) = 1.1 E 10

<u>Density of Electrons</u>

n(LT) = 5.0 E 11

<u>Density of Neutral Particles</u>

N(0) = 7.6 E 16

$N(O_2)$ = 7.5 E 16

$N(N_2)$ = 4.0 E 17

N(HE) = 3.4 E 13

Upper Mass Limit	40 AM U
Lower Mass Limit	1 AM U
Resolution	1 AM U

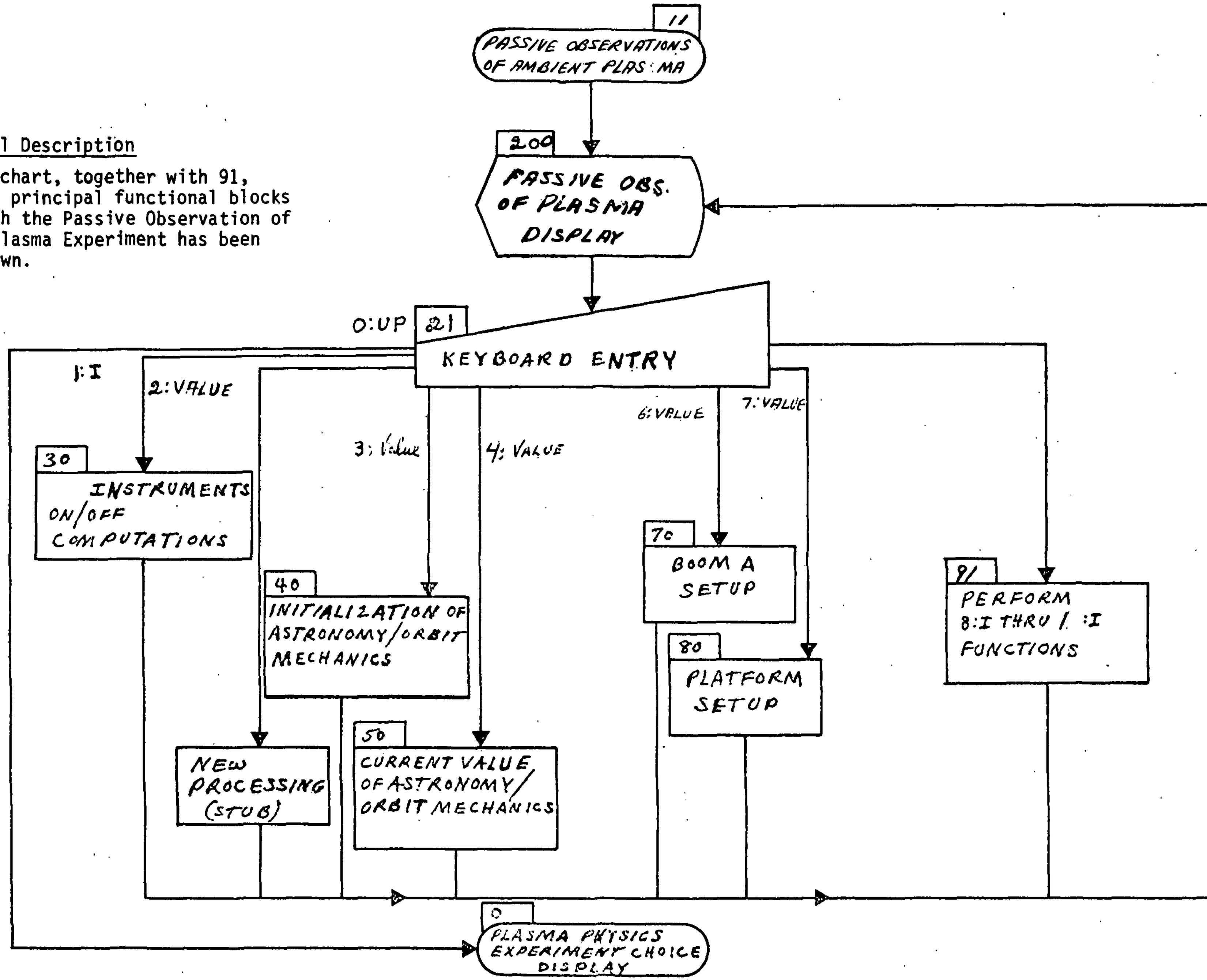
Planar Electron Trap

Lower Energy Limit	1 eV
Upper Energy Limit	1000 eV
Ion Temperature	1000 Deg. Kelvin

6.2.3 FLOWCHARTS AND DISPLAY FORMATS FOR THE PASSIVE OBSERVATION AMBIENT PLASMA EXPERIMENT

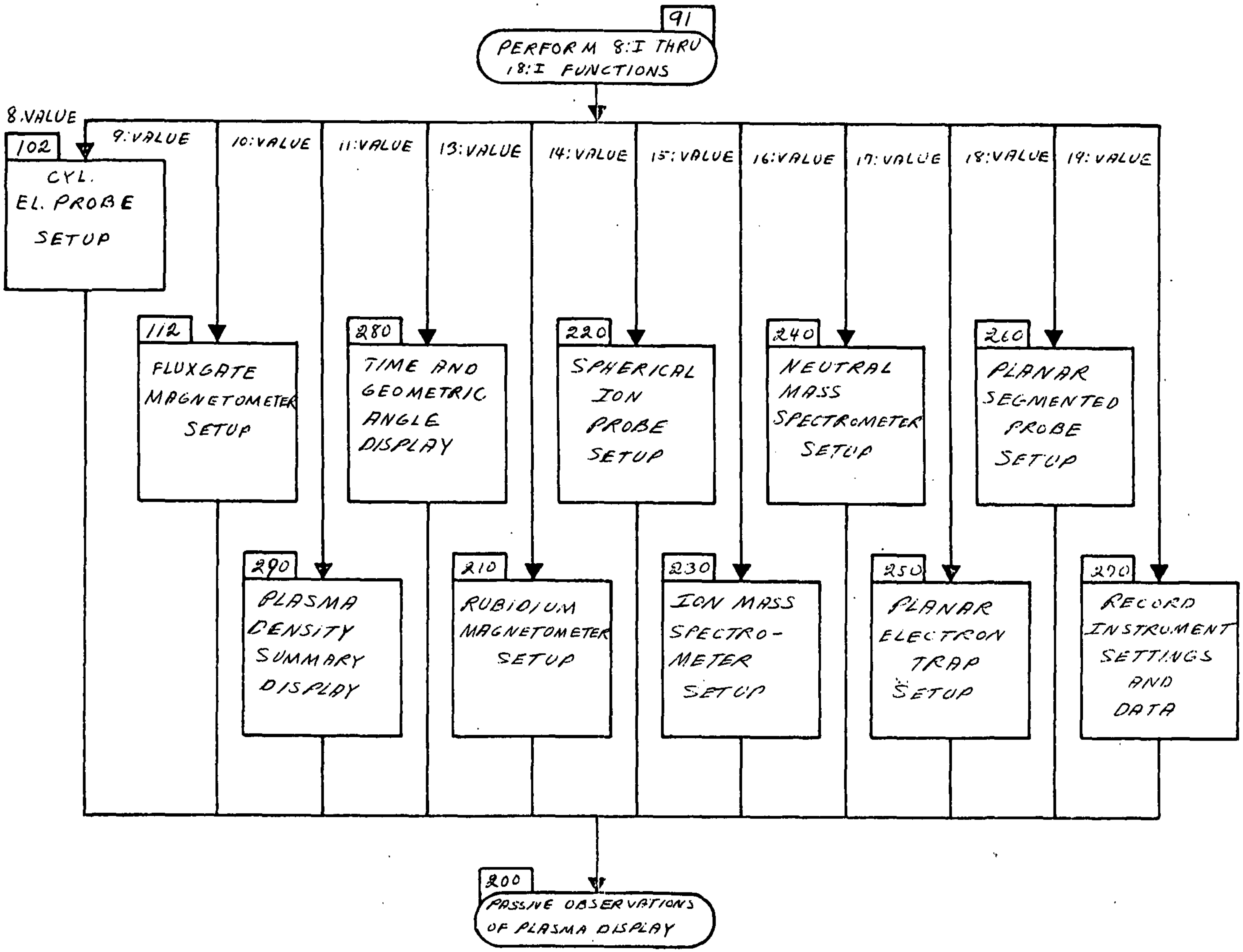
11 Functional Description

This flowchart, together with 91, shows the principal functional blocks into which the Passive Observation of Ambient Plasma Experiment has been broken down.



91 Functional Description

See Flowchart No. 11.



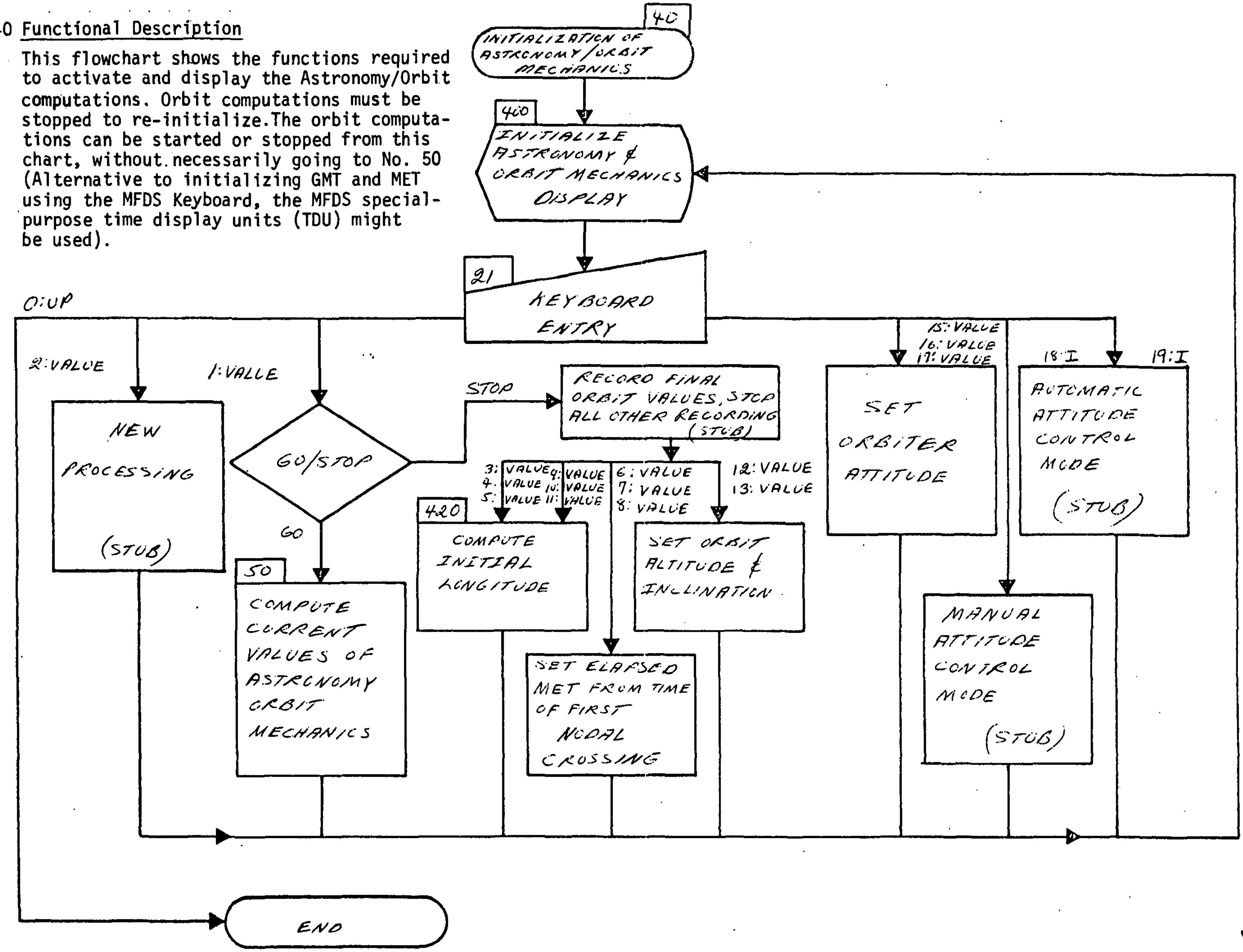
200 PASSIVE OBSERVATIONS OF
AMBIENT PLASMA

ERROR MSG:

0: PROCEDURES UP TO PLASMA PHYSICS EXPERIMENT CHOICE DISPLAY	UP/I/D		10: PLASMA DENSITY SUMMARY	I/D
			11: TIME & GEOMETRIC ANGLE SUMMARY	I/D
1: P.O. INSTRUMENTS	ON/OFF		12: SPARE	
	READY		13: RUBIDIUM MAGNETOMETER SETUP	I/D
2: SPARE			14: SPHERICAL ION PROBE SETUP	I/D
3: INITIALIZATION OF ASTRONOMY AND ORBIT MECHANICS QUANTITIES	I/D		15: ION MASS SPECTROMETER SETUP	I/D
4: CURRENT VALUES OF ASTRONOMY AND ORBIT MECHANICS QUANTITIES	I/D		16: NEUTRAL MASS SPECTROMETER SETUP	I/D
5: SPARE			17: PLANAR ELECTRON TRAP SETUP	I/D
6: BOOM A SETUP	I/D		18: PLANAR SEGMENTED PROBE SETUP	I/D
7: PLATFORM SETUP	I/D		19: RECORD INSTRUMENT SETTINGS AND DATA	I/D
8: CYL ELECTRON PROBE SETUP	I/D			
9: FLUXGATE MAGNETOMETER SETUP	I/D			

40 Functional Description

This flowchart shows the functions required to activate and display the Astronomy/Orbit computations. Orbit computations must be stopped to re-initialize.The orbit computations can be started or stopped from this chart, without necessarily going to No. 50 (Alternative to initializing GMT and MET using the MFDS Keyboard, the MFDS special-purpose time display units (TDU) might be used).



400 INITIALIZE ASTRONOMY AND ORBIT MECHANICS DISPLAY

ERROR MSG:

0: PROCEDURES ______ UP/I/D
UP TO ______________________

____

1: CALCULATE ORBIT/ASTRONOMY FUTURE PARAMETERS ______ GO/STOP

2: SPARE

3: SET FIRST DESCENDING NODE TIME LT_o ______ XX HRS

4: SET FIRST DESCENDING NODE TIME LT_o ______ XX MINS

5: SET FIRST DESCENDING NODE TIME LT_o ______ XX SECS

6: SET ELAPSED TIME MET_i ______ XX HRS

7: SET ELAPSED TIME MET_i ______ XX MINS

8: SET ELAPSED TIME MET_i ______ XX SECS

9: SET INITIAL GREENWICH MEAN TIME GMT_o ______ XX HRS

10: SET INITIAL GREENWICH MEAN TIME GMT_o ______ XX MINS

11: SET INITIAL GREENWICH MEAN TIME GMT_o ______ XX SECS

INITIAL EAST LONGITUDE ______ DEGREES

12: ORBIT INCLINATION ______ XX 0^o TO 90^o

13: ORBIT ALTITUDE ______ XXXX KM

14: SPARE

15: ORBITER ATTITUDE LINE OF NODES Γ ______ XXX DEGREES

16: ORBITER ATTITUDE INCLINATION Λ ______ XX DEGREES

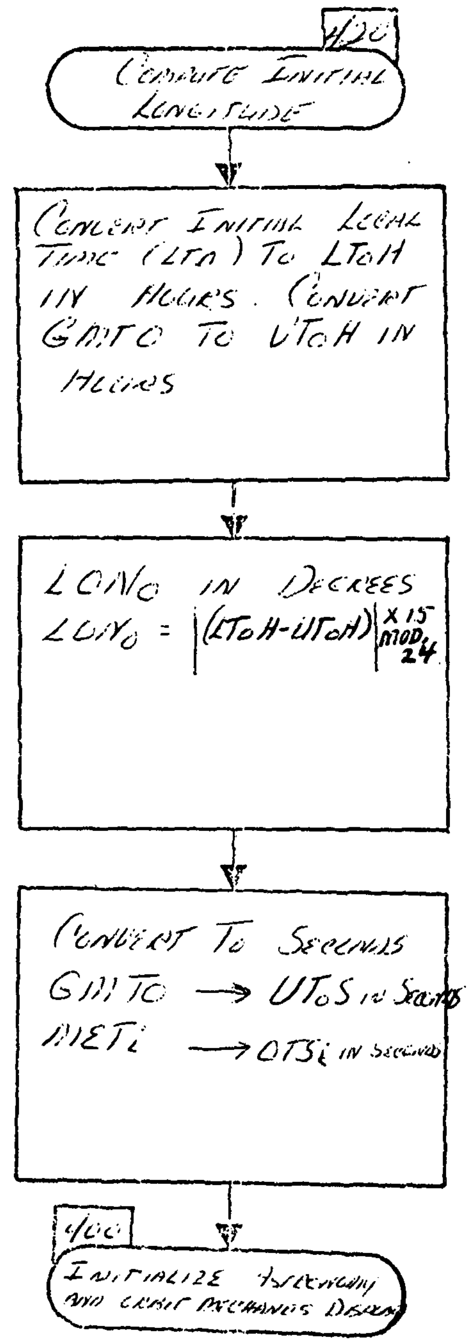
17: ORBITER ATTITUDE RIGHT ASC Δ ______ XXX DEGREES

18: MANUAL ATTITUDE CONTROL MODE ______ NO/I

19: AUTOMATIC ATTITUDE CONTROL MODE ______ NO/I

420 Functional Description

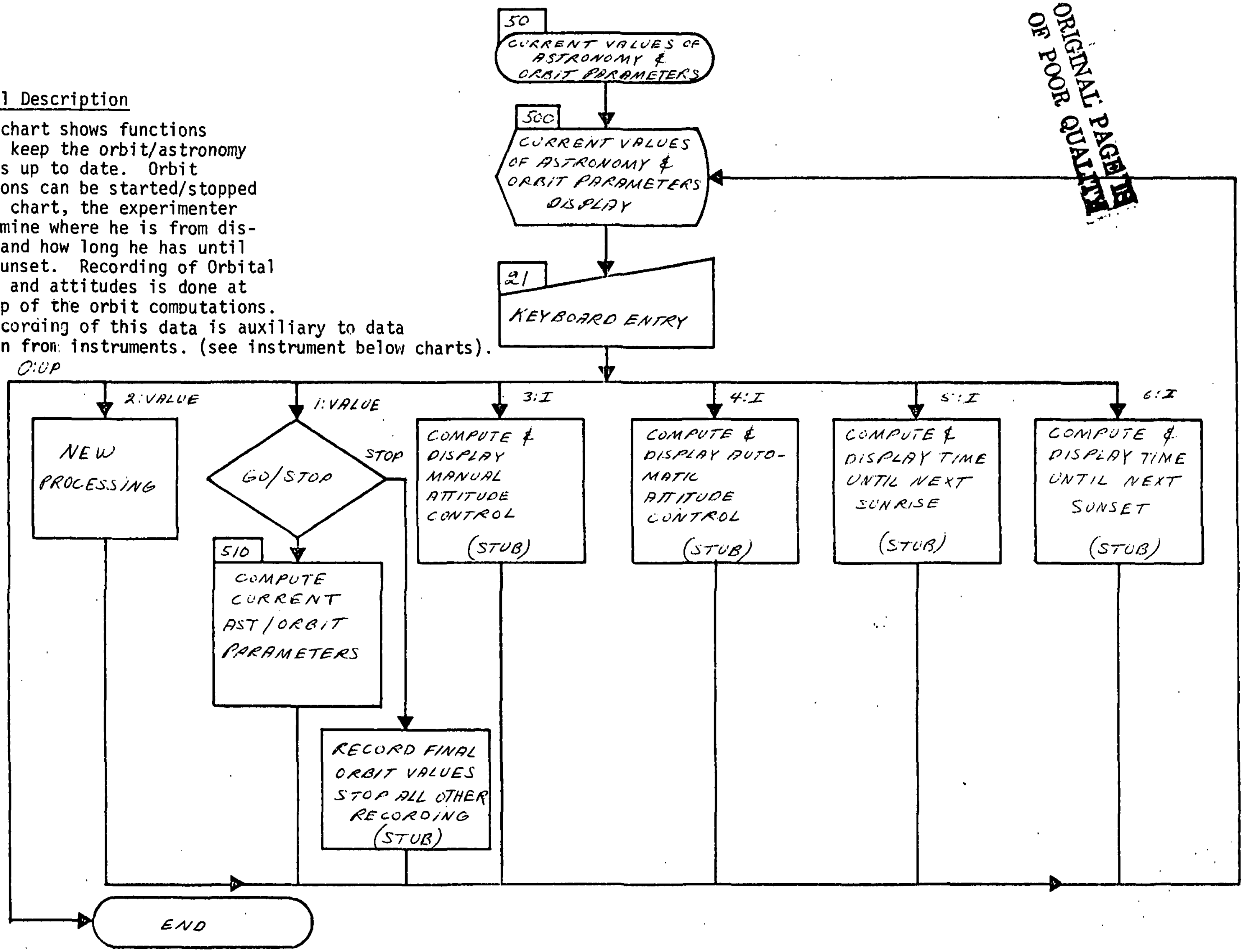
This flowchart shows conversion of time quantities to decimal hours and to seconds also calculation of the East longitude of the initial descending mode.



C.2

50 Functional Description

This flowchart shows functions needed to keep the orbit/astronomy parameters up to date. Orbit computations can be started/stopped from this chart, the experimenter can determine where he is from display 500 and how long he has until sunrise/sunset. Recording of Orbital positions and attitudes is done at start/stop of the orbit computations. (Other recording of this data is auxiliary to data collection from instruments. (see instrument below charts).



NOTE: GMT AND MET SHOWN ON TDU MFDS DISPLAYS.

500 CURRENT VALUES OF ASTRONOMY, ORBIT MECHANICS PARAMETERS

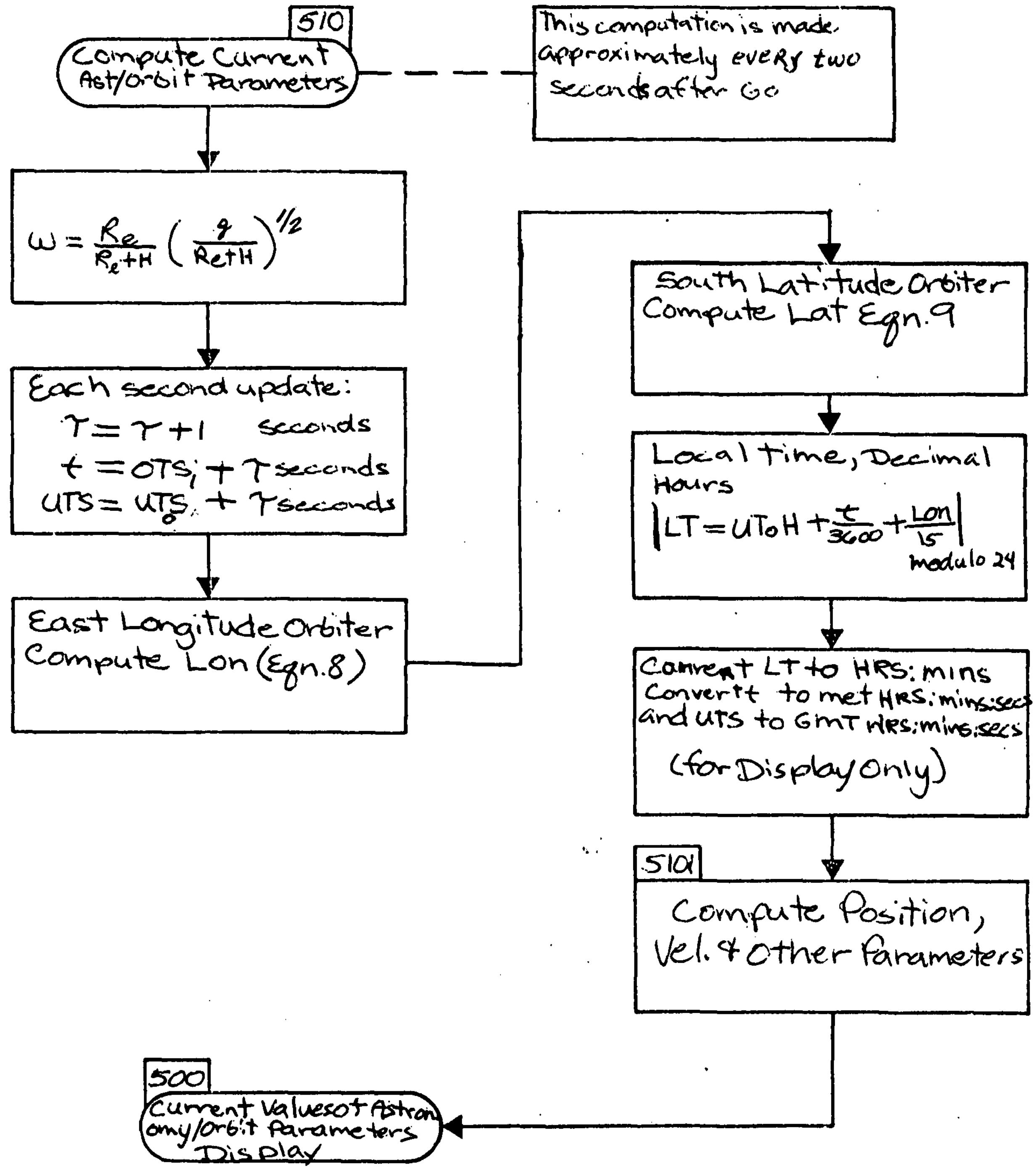
ERROR MSG:

0: PROCEDURES UP TO ______	____	UP/I/D
1: CALCULATE ORBIT/ASTRONOMY FUTURE PARAMETERS	____	GO/STOP
2: SPARE		
EARTH-CENTERED COORDINATES		
EAST LONGITUDE	[ ]	DEGREES
NORTH LATITUDE	[ ]	DEGREES
SOUTH LATITUDE	[ ]	DEGREES
ALTITUDE	[ ]	KILOMETERS
INCLINATION	[ ]	DEGREES
ORBITER LOCAL TIME	[ ]	HRS:MINS

ORBITER VELOCITY TOTAL	[ ]	M/SEC
EASTWARD	[ ]	M/SEC
NORTHWARD	[ ]	M/SEC
SOUTHWARD	[ ]	M/SEC
ORBITER ATTITUDE		
LINE OF NODES Γ	[ ]	DEGREES
INCLINATION Λ	[ ]	DEGREES
RIGHT ASC Δ	[ ]	DEGREES
3: MANUAL ATTITUDE CONTROL	____	NO/I
4: AUTOMATIC ATTITUDE CONTROL MODE	____	NO/I
5: TIME UNTIL SUNRISE	[ ]	MINS
6: TIME UNTIL SUNSET	[ ]	MINS
7: SPARE		

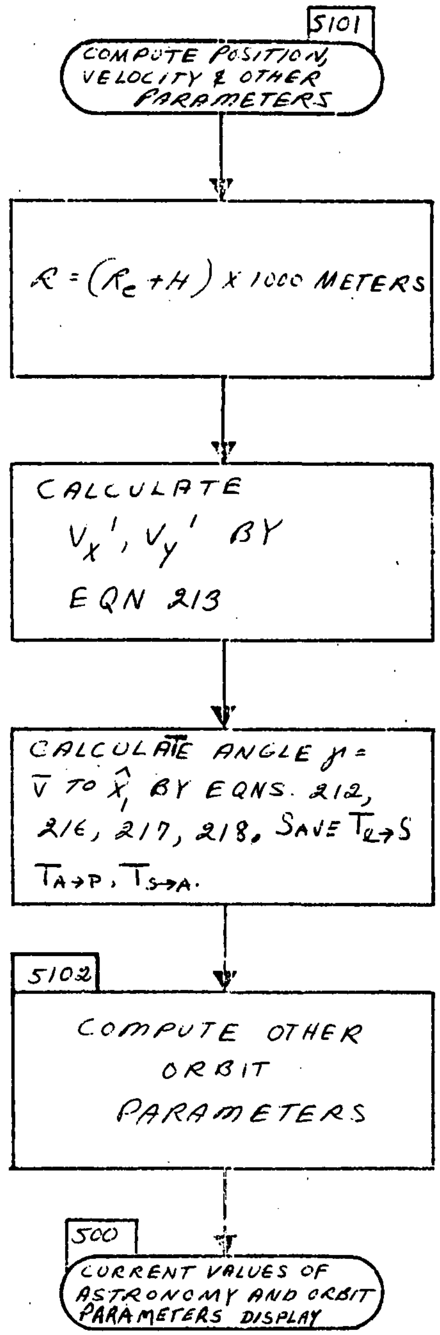
510 Functional Descrition

This flowchart shows how the astronomy/orbit parameters are updated. This computation, once started, continues regardless of what other action the experimenter takes, except specifically stopping the orbit computation itself.



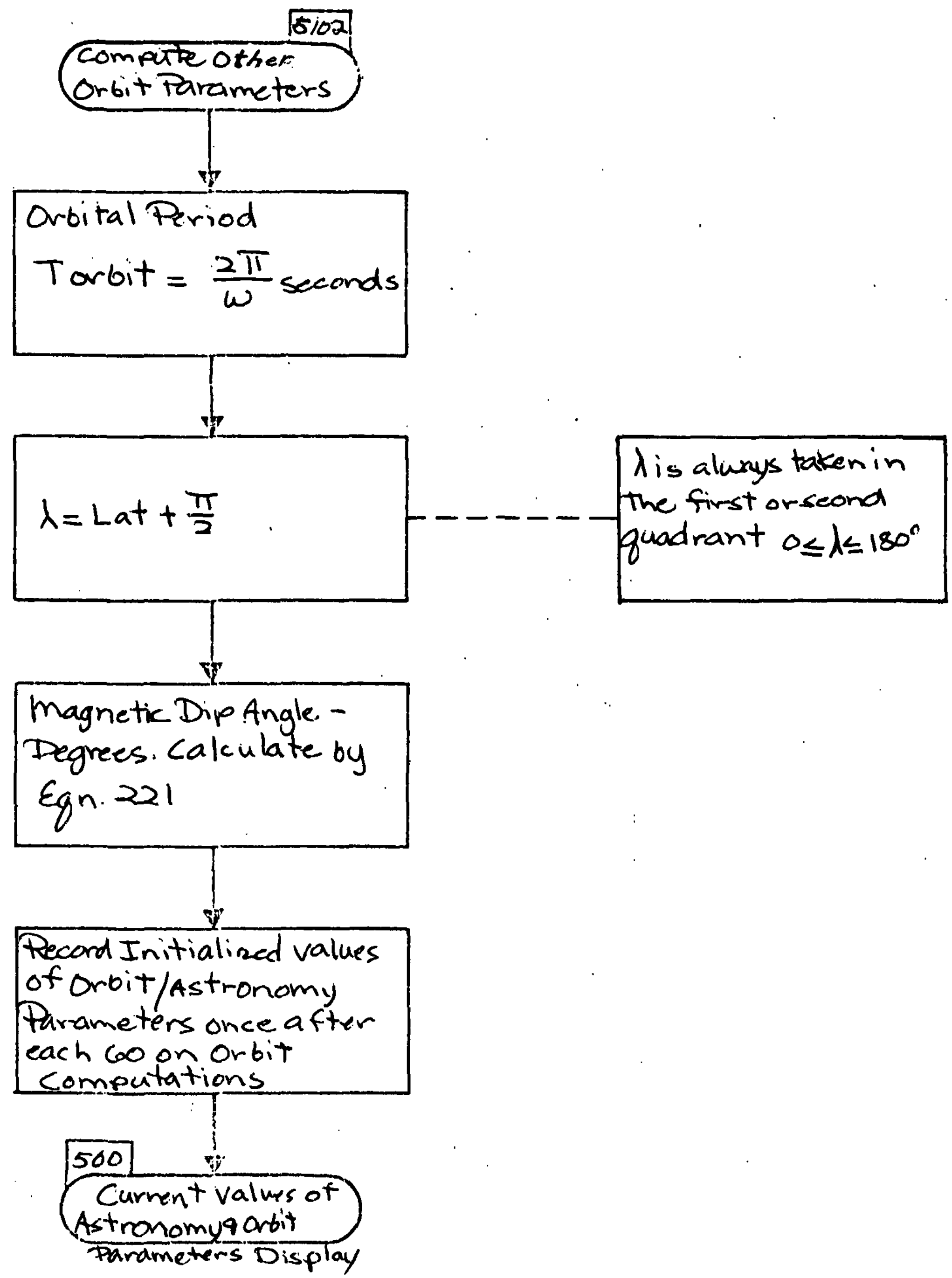
5101 Functional Description

See 510



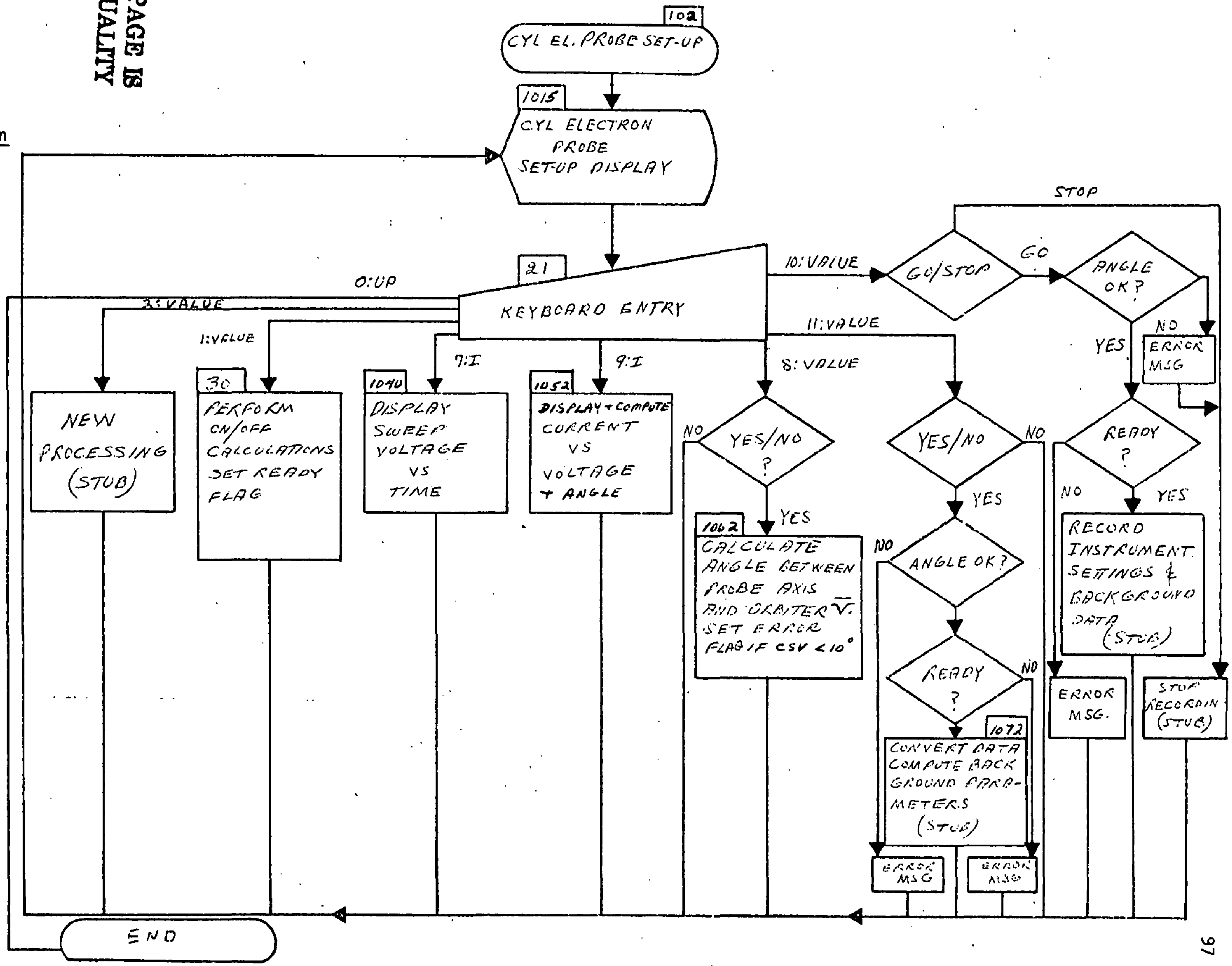
5102 Functional Description

See 510



102 Functional Description

This flowchart shows the processing of the set up of the cylindrical electron probe instrument, including a check on probe sweep. The equations of 1052 are used in the simulation and are based on theory. If an actual instrument were connected to the computer block 1072 would be used.



1015 CYLINDRICAL ELECTRON PROBE
SETUP DISPLAY

ERROR MSG:

0: PROCEDURES UP/I/D
UP TO

1: PROBE ON/OFF

READY

2: SPARE

3: SPARE

4: SPARE

5: SPARE

6: SPARE

7: DISPLAY SWEEP VOLTAGE I/NO

ANGLE BETWEEN PROBE AXIS & ORBITER VELOCITY $\overline{V}$

8: COMPUTE ANGLE DEGREES YES/NO

9: DISPLAY CURRENT VS. VOLTAGE I/NO

10: RECORD SETTINGS/BACKGROUND DATA GO/STOP

11: COMPUTE ELECTRON BACKGROUND PARAMETERS YES/NO

ELECTRON TEMPERATURE DEGREES KELVIN

ELECTRON VOLTS VOLTS

ELECTRON DENSITY n_e PER/M^3

LATITUDE LAT DEGREES

LOCAL TIME LT HRS:MINS

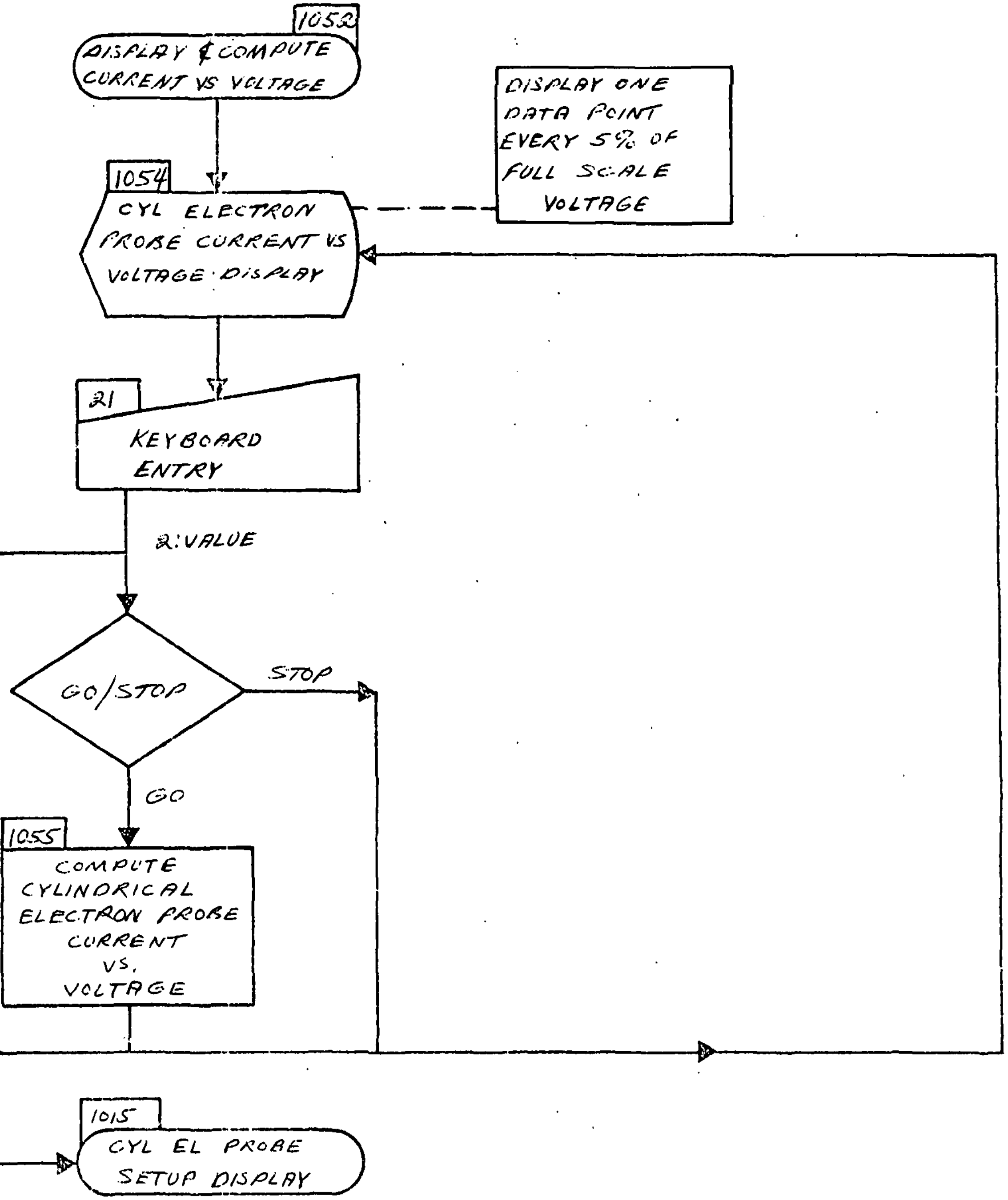
ANGLE PLATFORM X_f TO V DEGREES

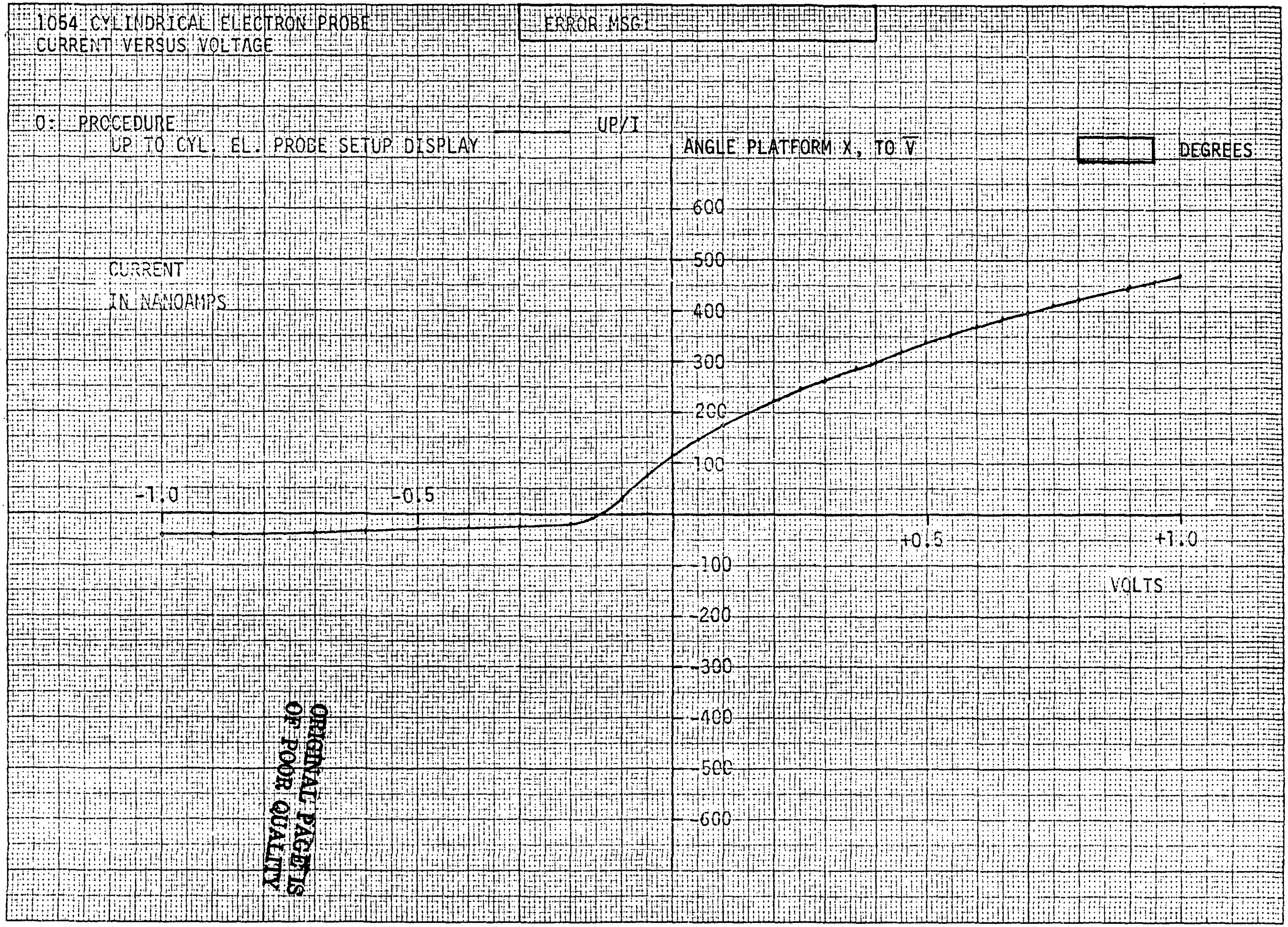
ALTITUDE H KM.

MAGNETIC DIP ANGLE DEGREES

1052 Functional Description

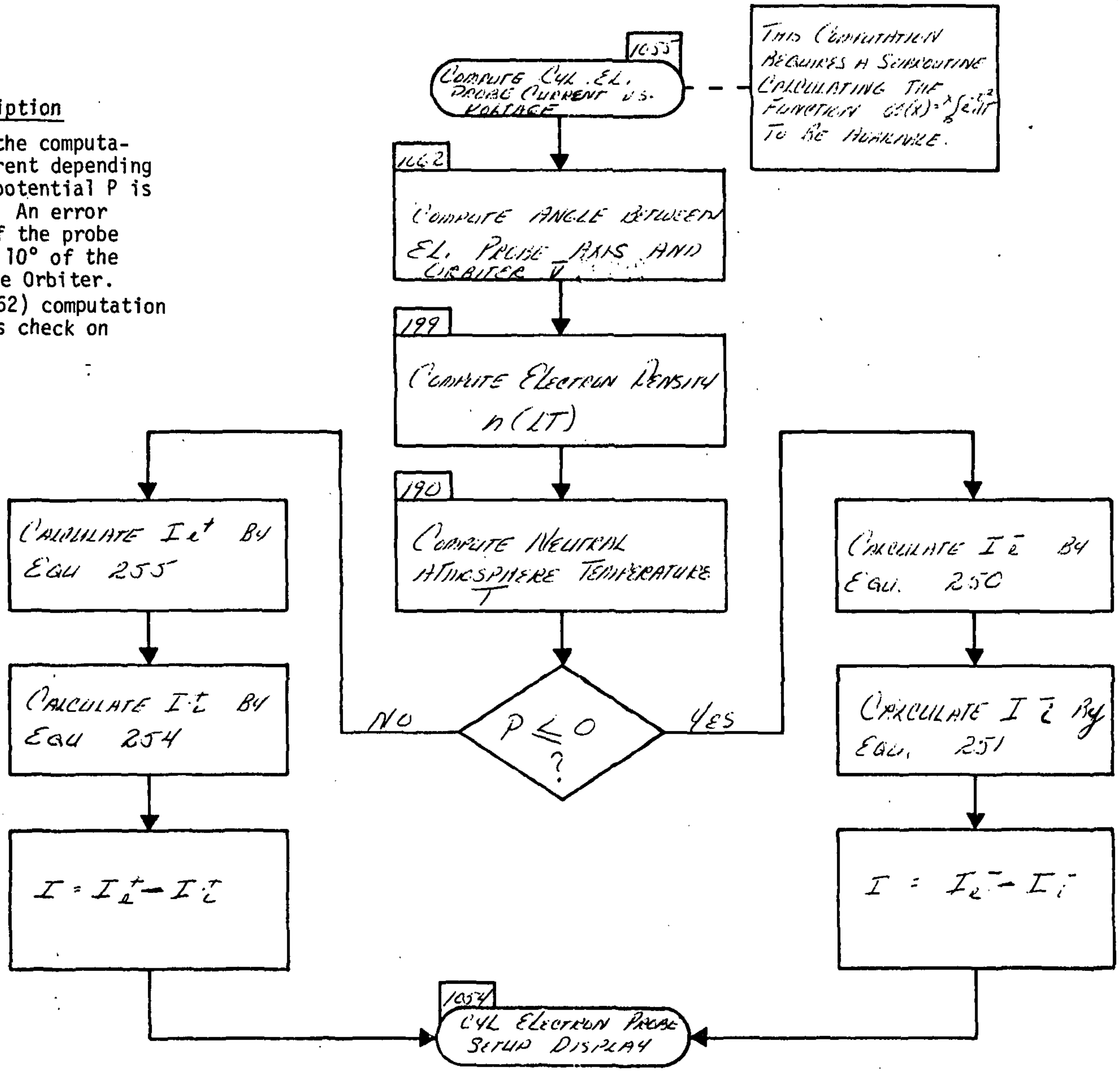
This flowchart shows the relationship of the probe current, voltage and angle computations and the proximate displays involved.




1054 CYLINDRICAL ELECTRON PROBE
CURRENT VERSUS VOLTAGE
ERROR MSG:
0: PROCEDURE
UP TO CYL. EL. PROBE SETUP DISPLAY
UP/I
ANGLE PLATFORM X, TO $\overline{V}$
DEGREES
CURRENT
IN NANOAMPS
600
500
400
300
200
100
-100
-200
-300
-400
-500
-600
-1.0
-0.5
+0.5
+1.0
VOLTS
ORIGINAL PAGE IS
OF POOR QUALITY

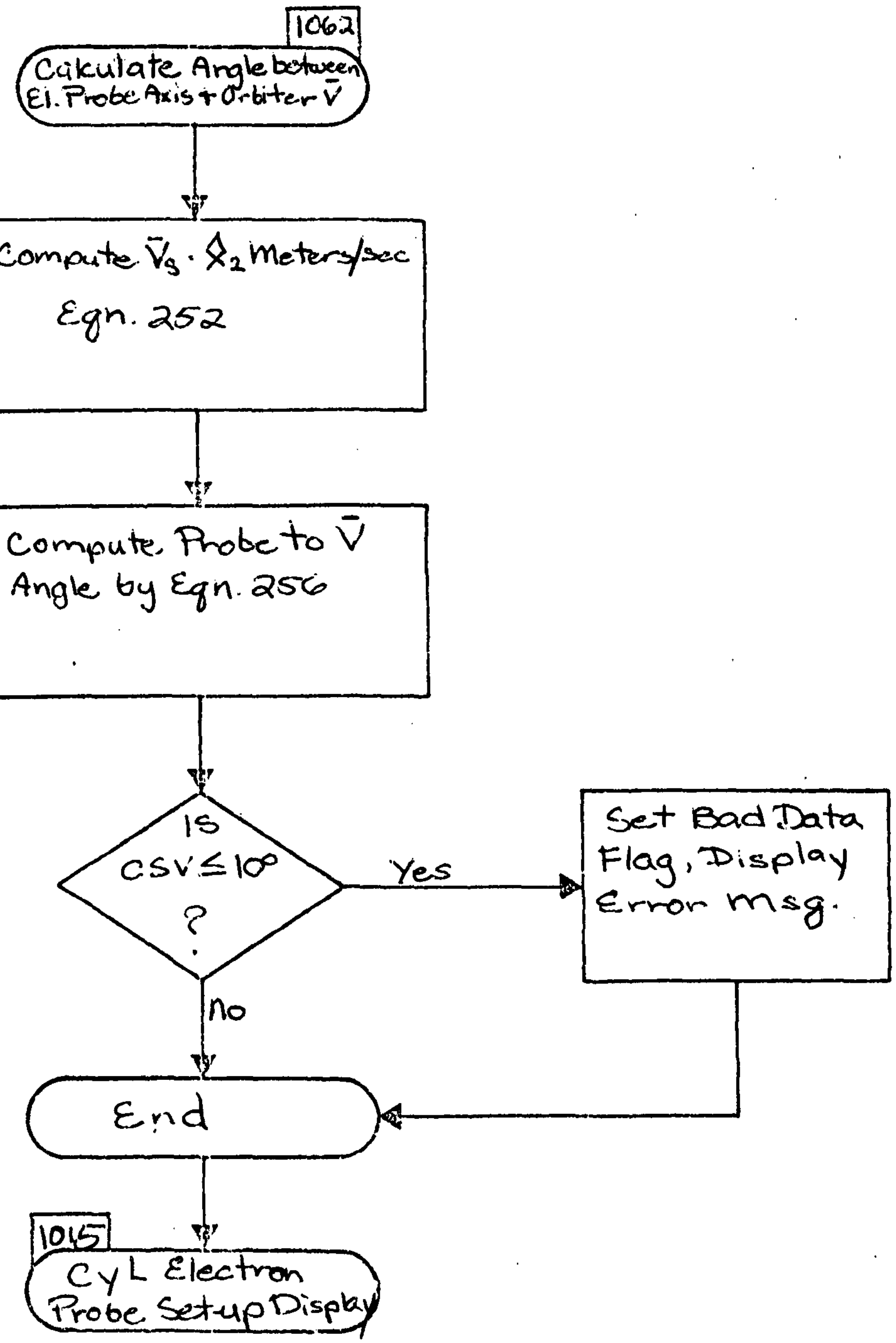
1055 Functional Description

This flowchart shows the computation of the Probe current depending on whether the Probe potential P is positive or negative. An error message will result if the probe axis points to within 10° of the velocity vector of the Orbiter. The repeated (with 1062) computation serves as a continuous check on probe angles.



1062 Functional Description

This flowchart shows a computation of the probe angle (normally oriented near 90° to vel. vector $\overline{V}$) as a subroutine. In addition a check is made to make sure that the probe axis is not pointing within 10° of parallel to $\overline{V}_s$ - which will yield erroneous data.



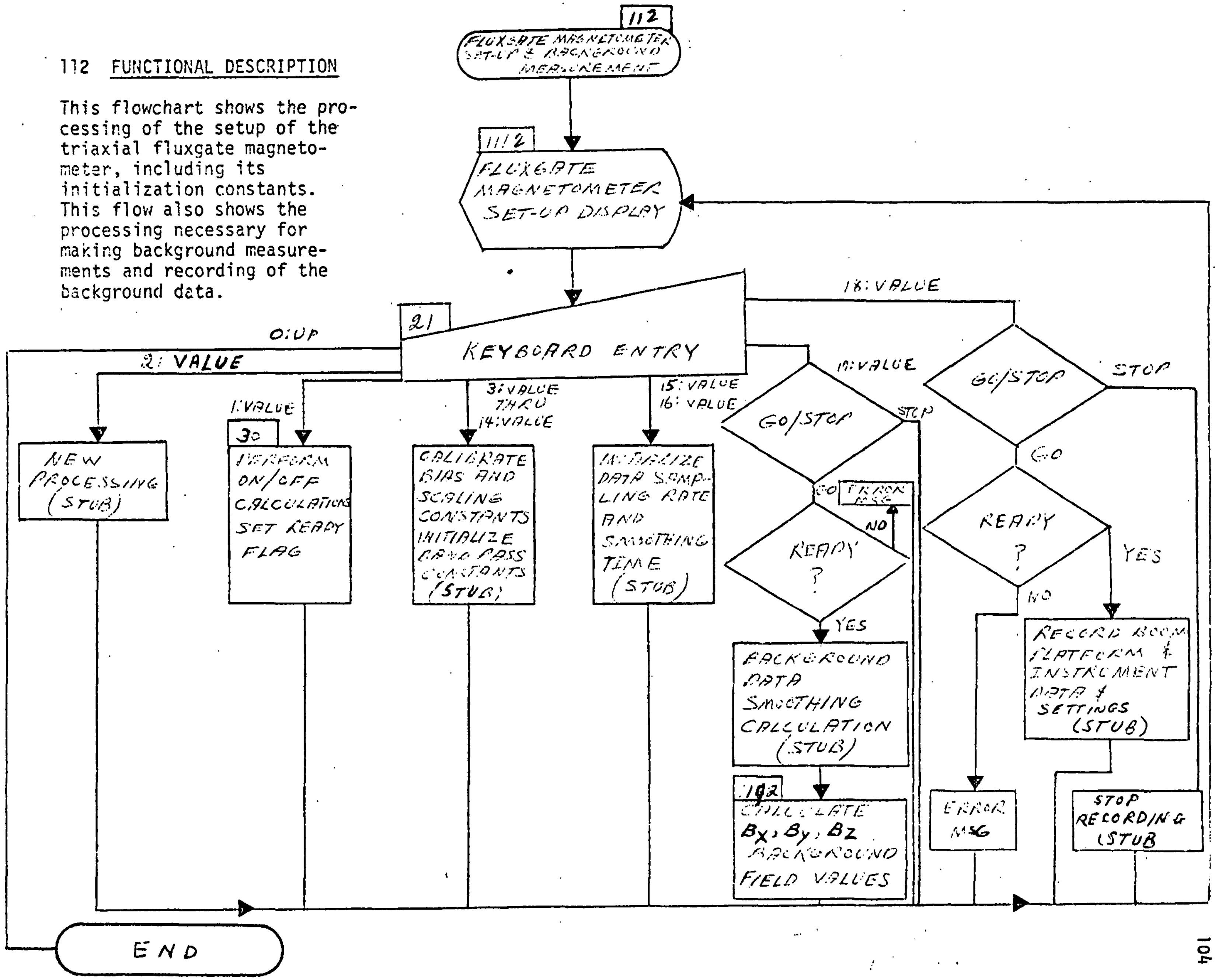
1040 CYLINDRICAL ELECTRON PROBE
VOLTAGE VERSUS TIME

ERROR MSG:

0: PROCEDURE ________UP/I
UP TO CYL. EL PROBE SETUP DISPLAY

112 FUNCTIONAL DESCRIPTION

This flowchart shows the processing of the setup of the triaxial fluxgate magnetometer, including its initialization constants. This flow also shows the processing necessary for making background measurements and recording of the background data.



111 2 FLUXGATE MAGNETOMETER SETUP DISPLAY

ERROR MSG:

0: PROCEDURE & ENTRY INSTRUCTIONS ______ UP/I/D
UP TO ____________________

____

1: MAGNETOMETER ______ ON/OFF

[   ] READY

2: SPARE

COIL BIAS, SCALE FACTOR, BANDPASS

3: SPARE

4: SPARE

5: SPARE

6: SPARE

7: SPARE

8: SPARE

9: SPARE

10: SPARE

11: SPARE

12: SPARE

13: SPARE

14: SPARE

15: TAKE DATA ______ TIMES PER CYCLE

16: AVERAGE OVER ______ CYCLES

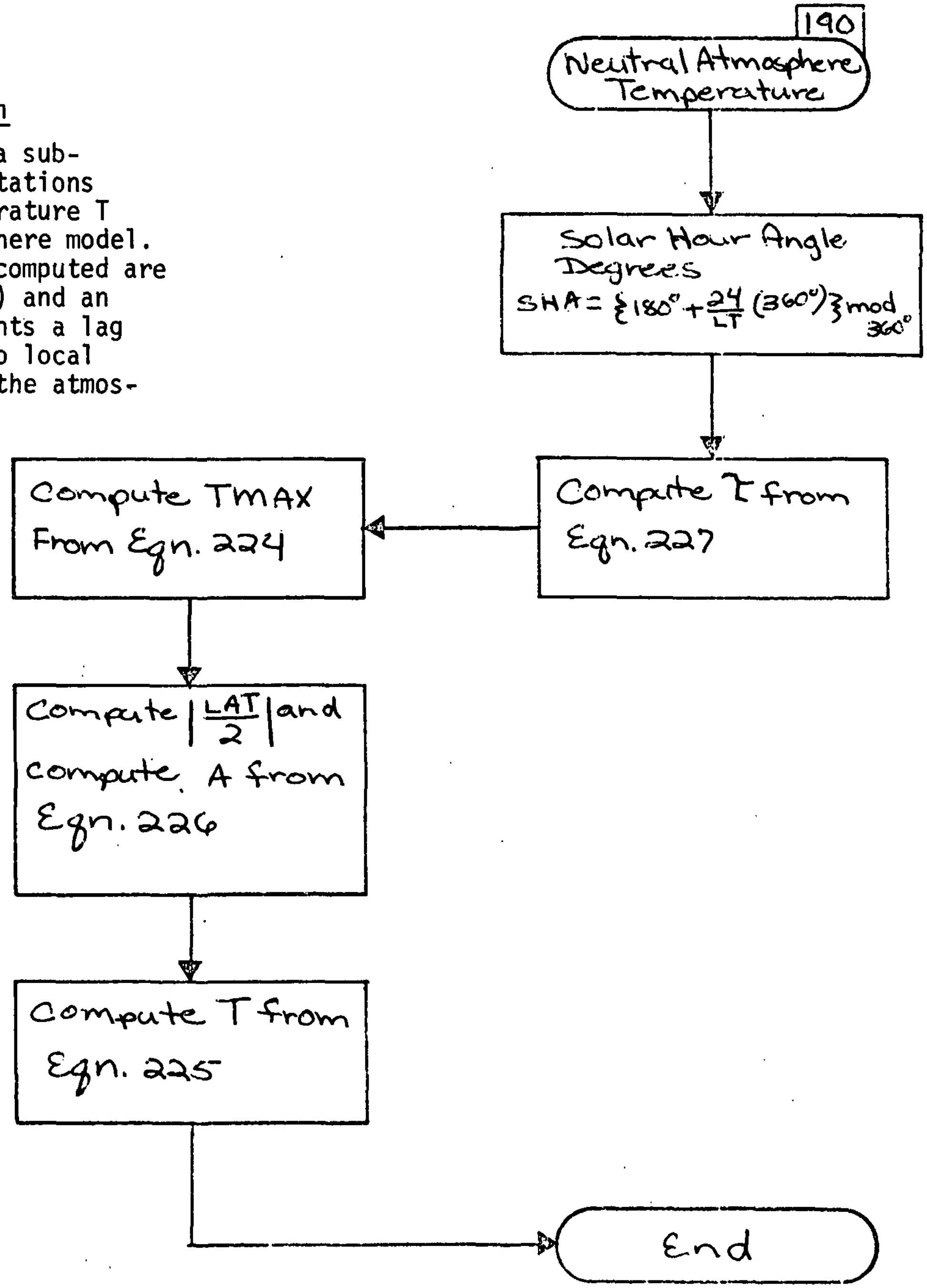
17: BACKGROUND MEASUREMENTS ______ GO/STOP

BACKGROUND B-FIELD VALUES		
BX	______	GAMMA
BY	______	GAMMA
BZ	______	GAMMA
BT	______	GAMMA

18: RECORD BACKGROUND DATA AND INSTRUMENT SETTING ______ GO/STOP

190 Functional Description

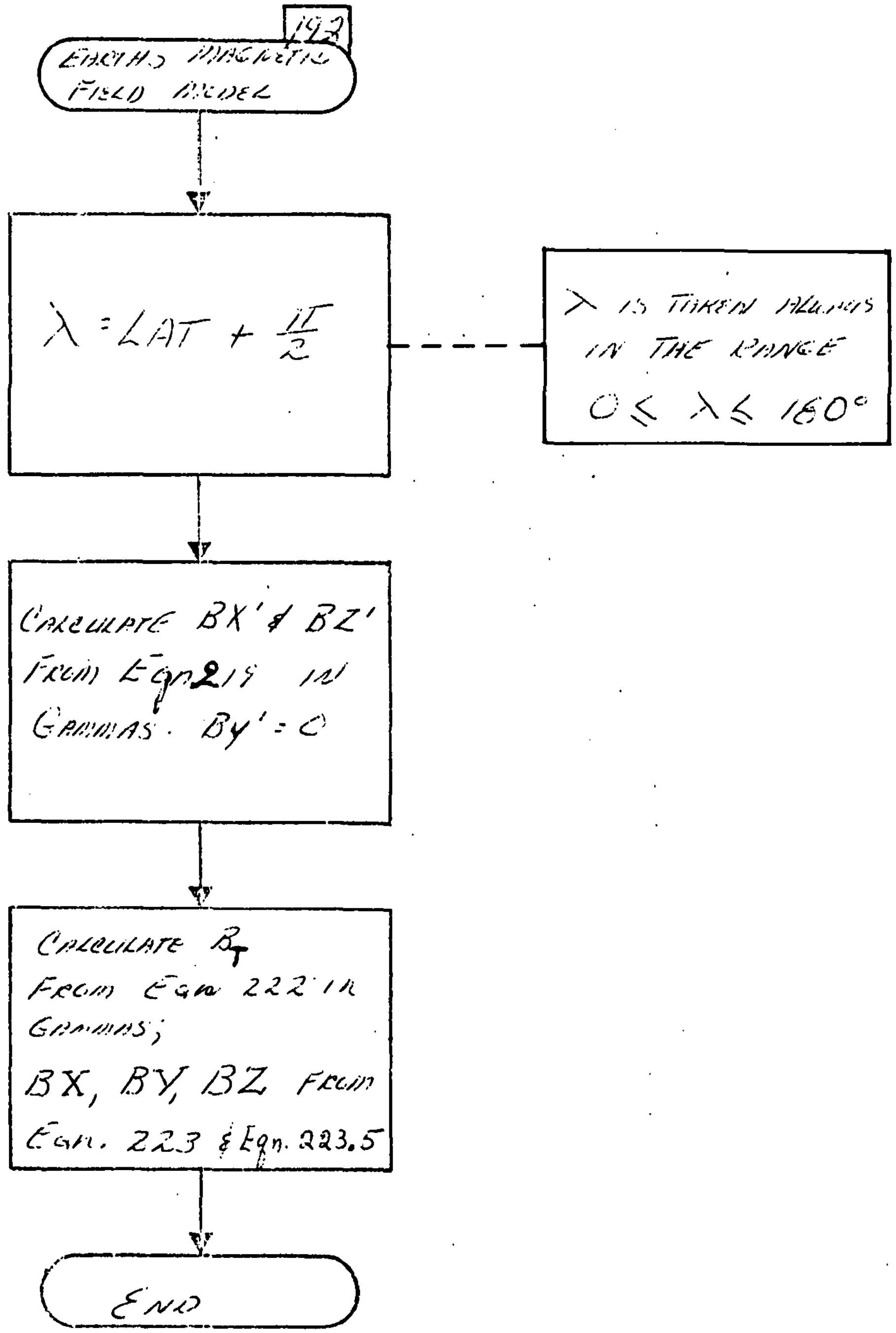
This flowchart shows a subroutine for the computations of the Absolute Temperature T in the neutral atmosphere model. Auxiliary quantities computed are solar hour angle (SHA) and an angle τ which represents a lag in density relative to local time at any point in the atmosphere.



Functional Description

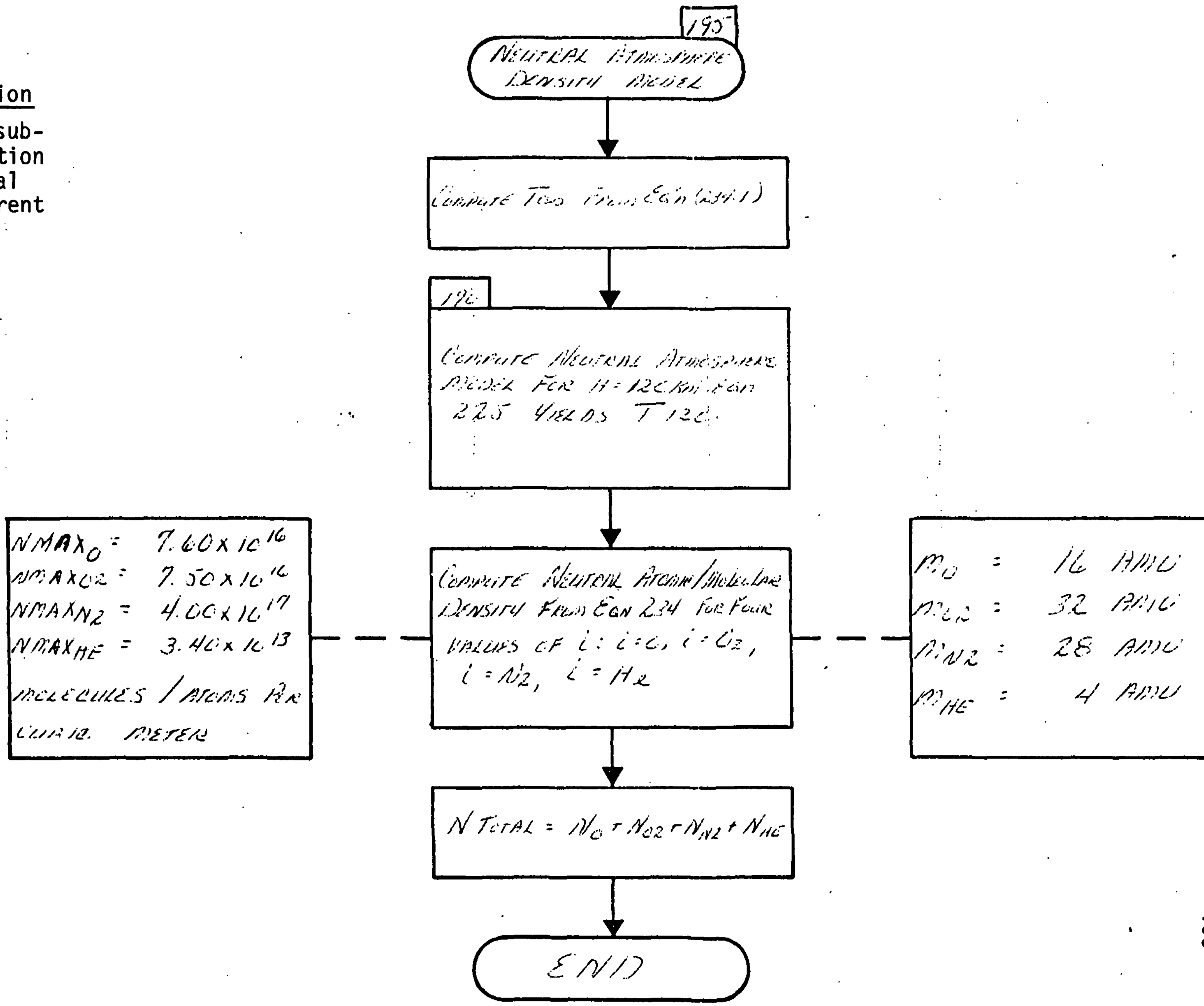
This flowchart shows a subroutine for the computation of the X' and Y' components of the earth's magnetic field. Since the axis of symmetry of the magnetic field is along the geographical earth polar axis, BY'=0. B_T is also computed.

Finally, BX, BY and BZ are computed based on orbiter, boom and platform orientations via a very general transformation 223 and 223.5.



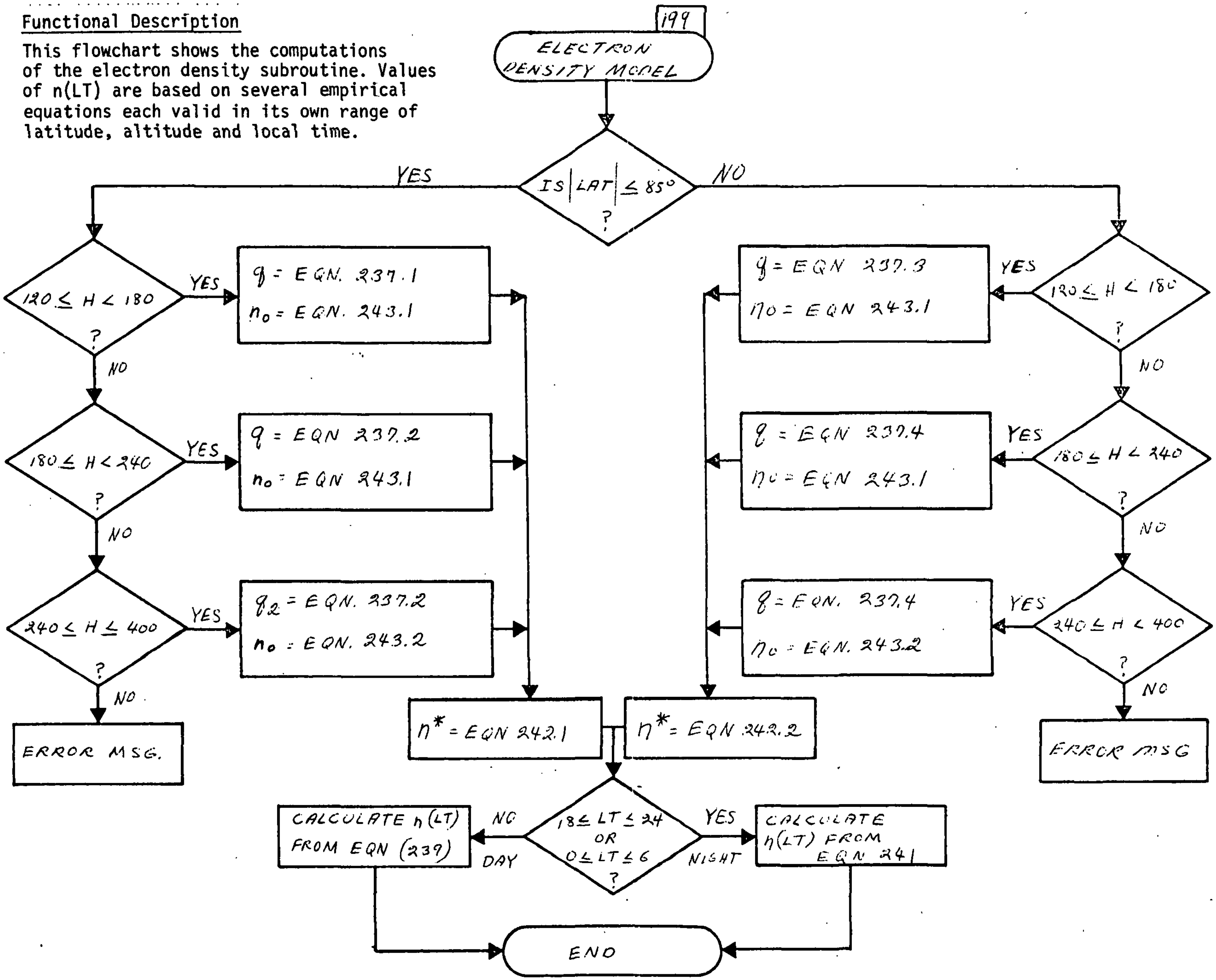
195 Functional Description

This flowchart shows a subroutine for the computation of the Density of Neutral particles of four different species.



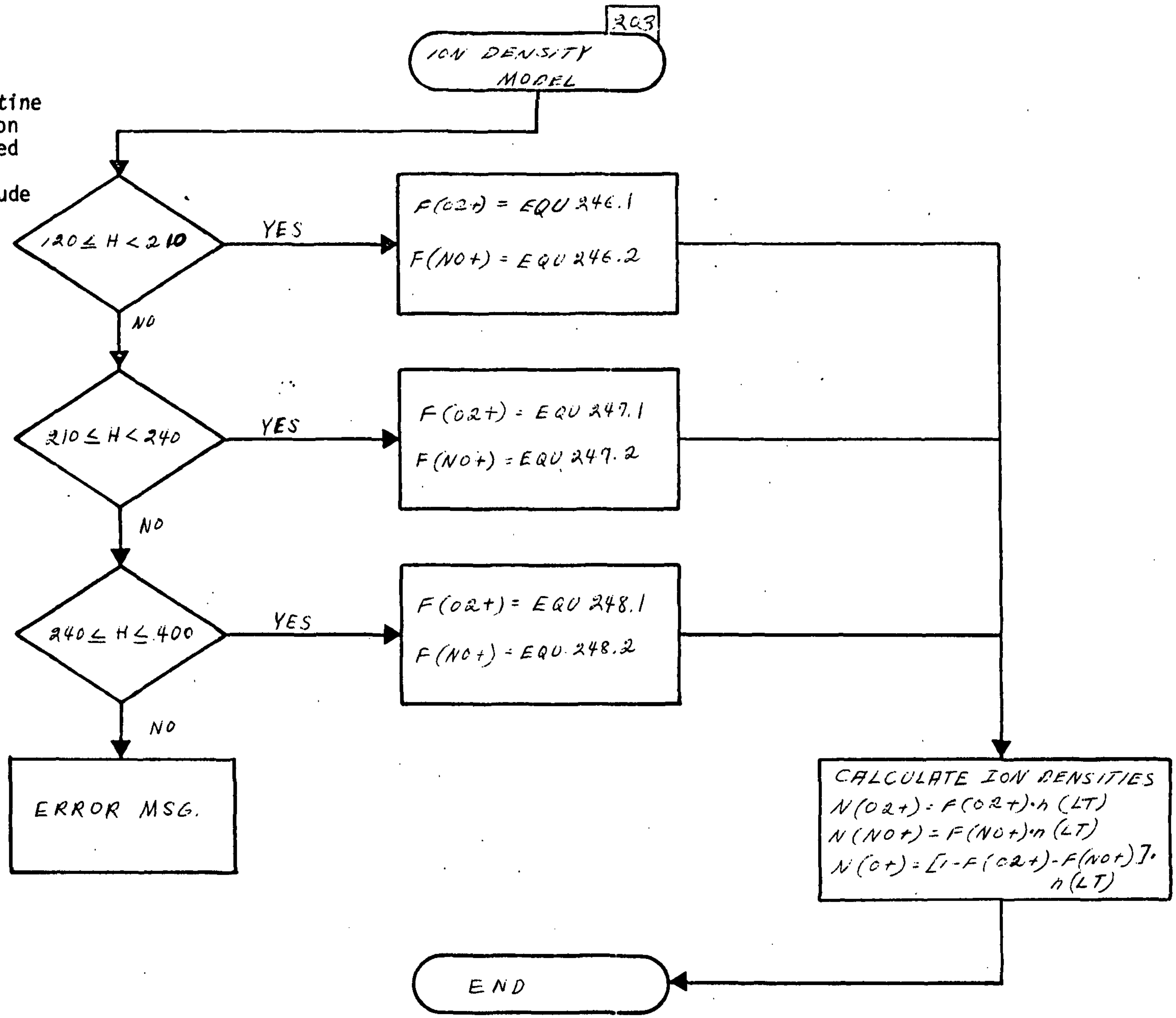
Functional Description

This flowchart shows the computations of the electron density subroutine. Values of n(LT) are based on several empirical equations each valid in its own range of latitude, altitude and local time.



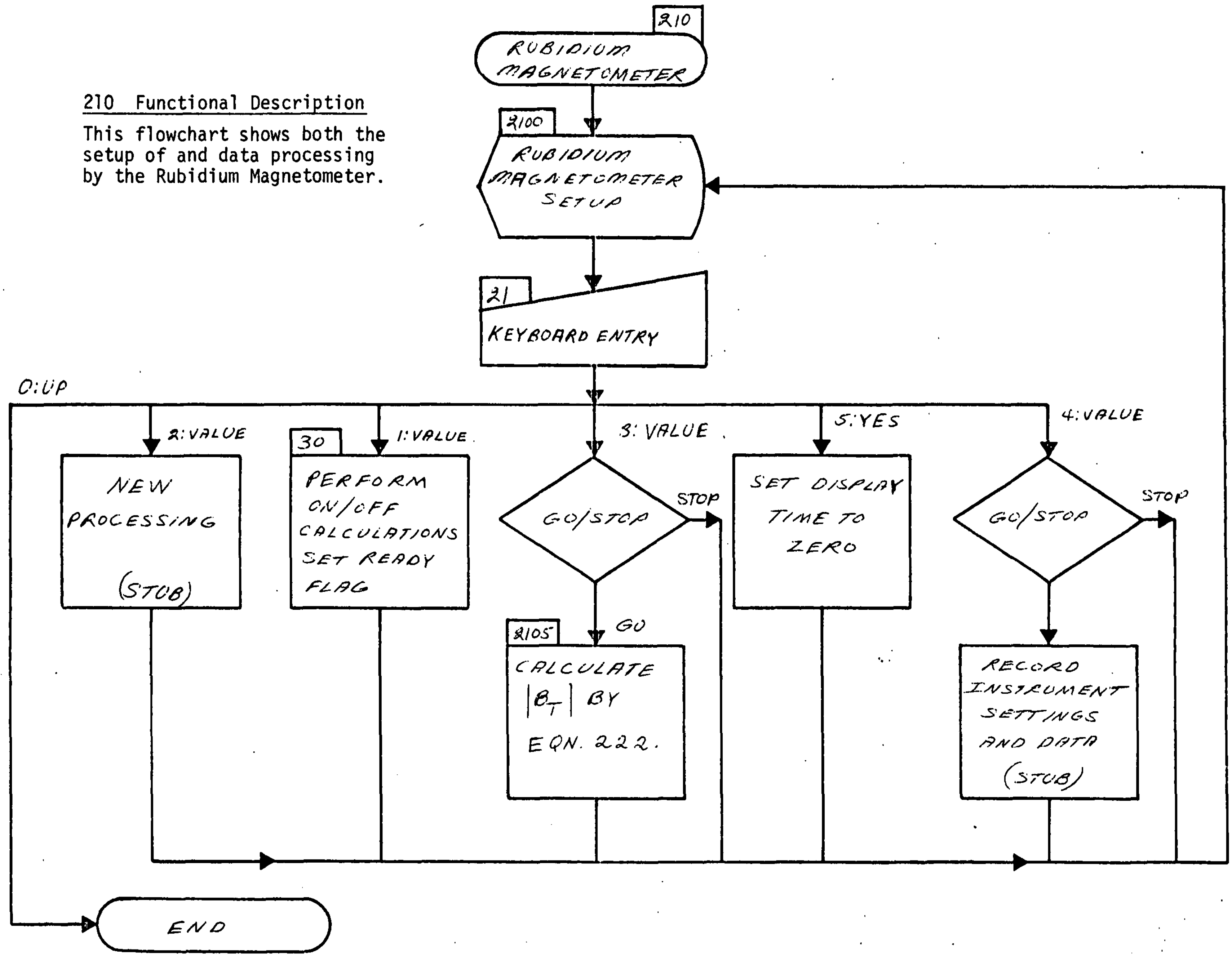
Functional Description

This flowchart shows a subroutine to compute values of F, the ion density. Values of F are based on empirical equations, each valid within a specific altitude range. Ion densities are assumed proportional to the local electron density n(LT).



210 Functional Description

This flowchart shows both the setup of and data processing by the Rubidium Magnetometer.



NOTE: ROLLOVER OF THE TIME AXIS IS REQUIRED FOR THIS DISPLAY

2100 RUBIDIUM MANETOMETER DISPLAY

ERROR MSG:

0: PROCEDURES ________ UP/I/D
UP TO ________________
____

1: RUBIDIUM MAGNETOMETER _____ ON/OFF
[ ] READY

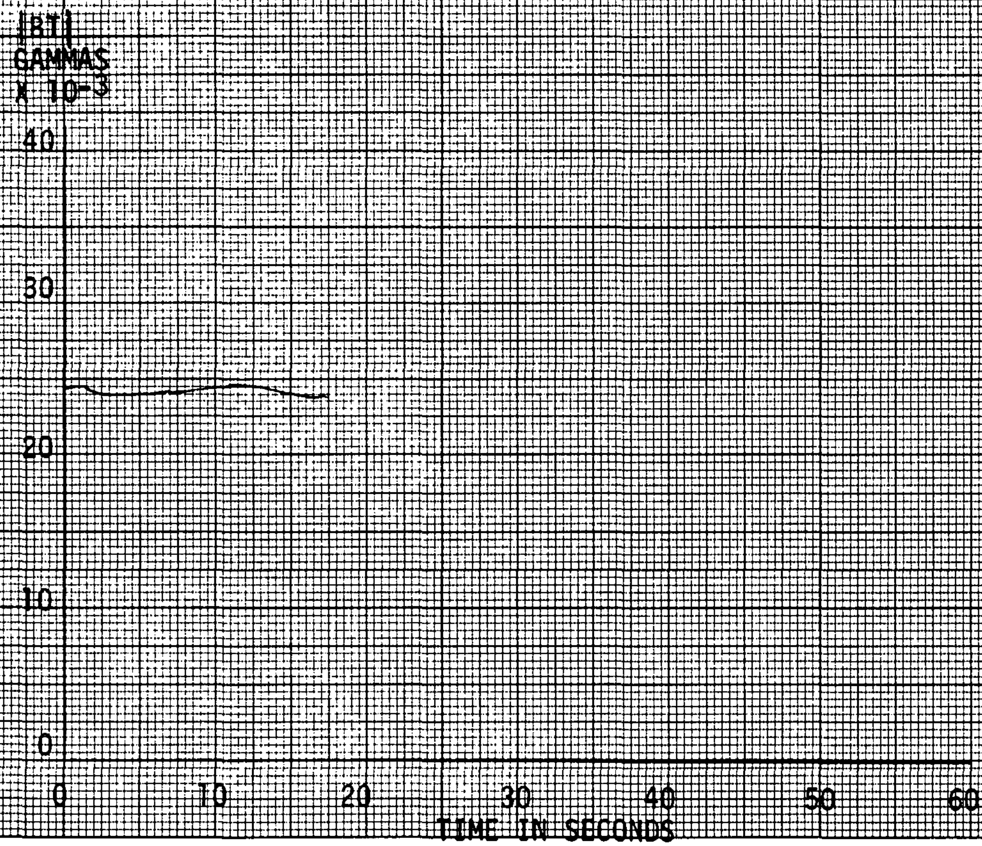
2: SPARE

3: RECEIVE MAGNETIC DATA _____ GO/STOP

4: RECORD INSTRUMENTS SETTINGS _____ GO/STOP
AND DATA

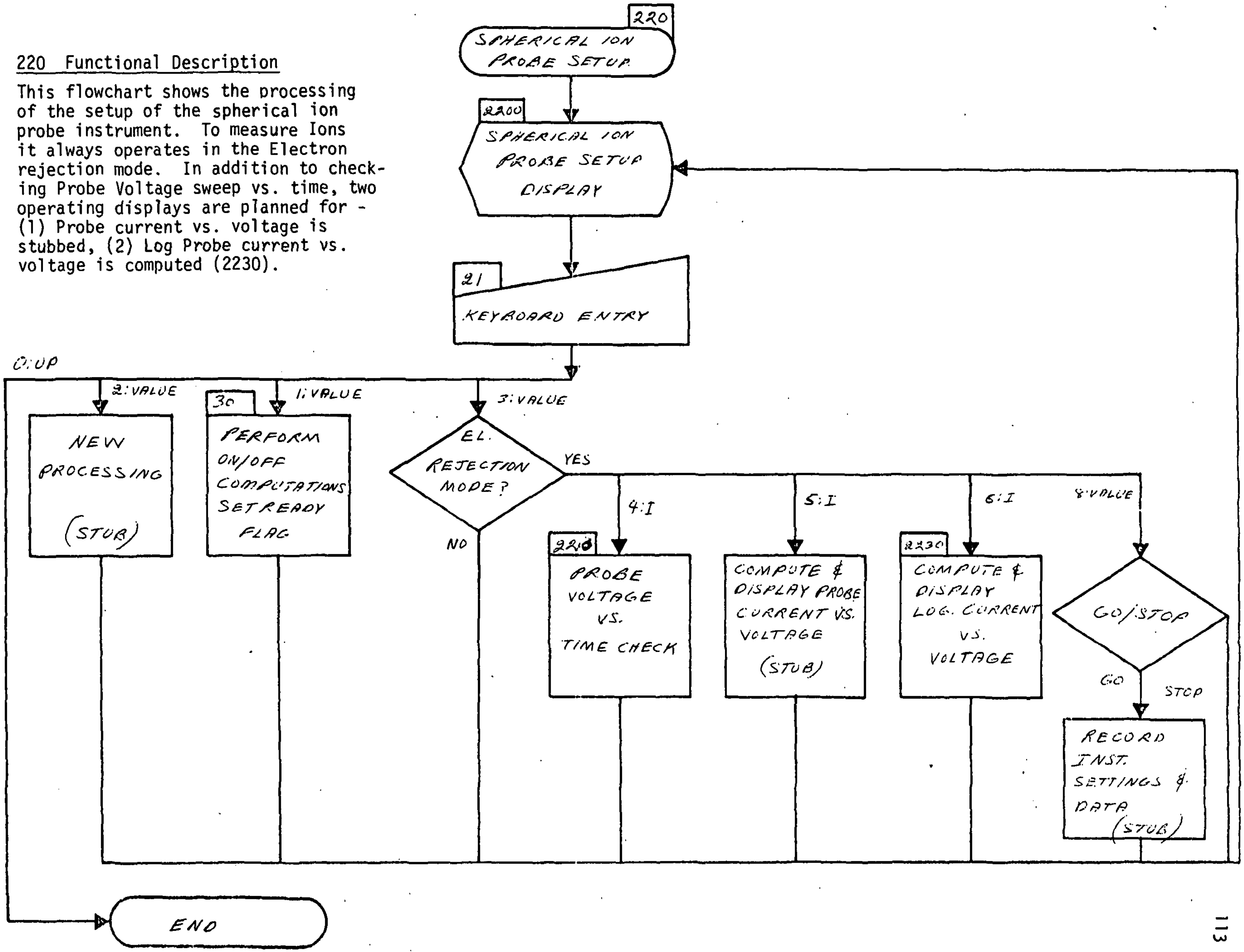
5: SET DISPLAY TIME TO ZERO _____ YES

LATITUDE	[ ]	DEGREES
LONGITUDE	[ ]	DEGREES
LOCAL TIME	[ ]	HRS:MINS
ALTITUDE	[ ]	KM
MAGN. DIP ANGLE	[ ]	DEGREES



220 Functional Description

This flowchart shows the processing of the setup of the spherical ion probe instrument. To measure Ions it always operates in the Electron rejection mode. In addition to checking Probe Voltage sweep vs. time, two operating displays are planned for - (1) Probe current vs. voltage is stubbed, (2) Log Probe current vs. voltage is computed (2230).



2200 SPHERICAL ION PROBE
SETUP DISPLAY

ERROR MSG:

0: PROCEDURES
UP TO ______ UP/I/D

1: SPHERICAL ION PROBE ______ ON/OFF

[ ] READY

2: SPARE

3: PROBE IN ELECTRON REJECTION MODE ______ YES/NO

4: DISPLAY PROBE VOLTAGE VS. TIME ______ I/NO

5: DISPLAY PROBE CURRENT VS VOLTAGE ______ I/NO

6: DISPLAY LOG PROBE CURRENT VS. VOLTAGE ______ I/NO

7: SPARE

8: RECORD INSTRUMENT SETTINGS & DATA ______

LATITUDE LAT [ ] DEGREES

LOCAL TIME LT [ ] HRS:MINS

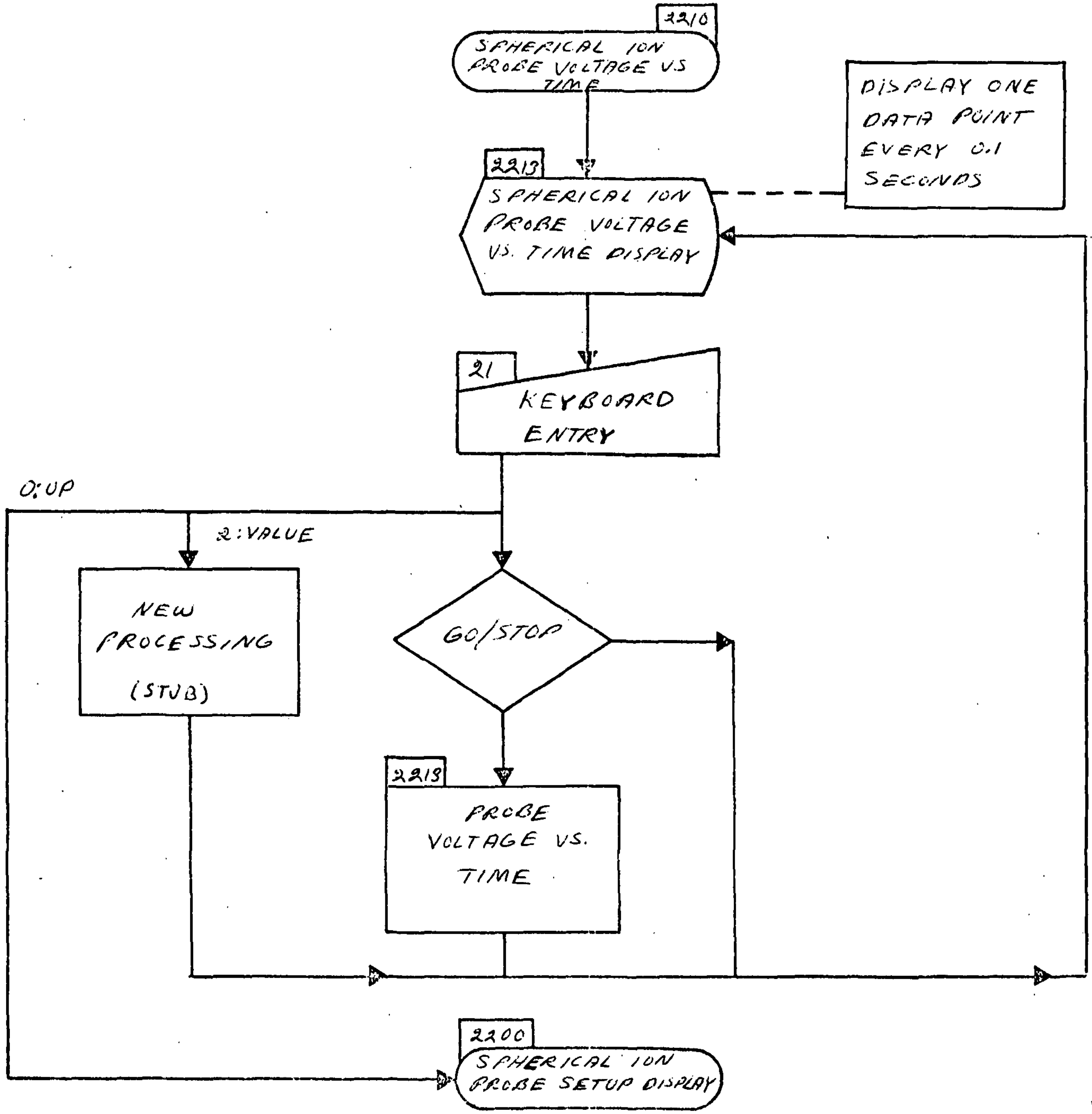
ANGLE PLATFORM TO $\bar{V}$ [ ] DEGREES

ALTITUDE (H) [ ] KM

MAGNETIC DIP ANGLE [ ] DEGREES

2210 <u>Functional Description</u>

This flowchart shows the relationship of the Probe Voltage vs. Time computation to the proximate displays involved.



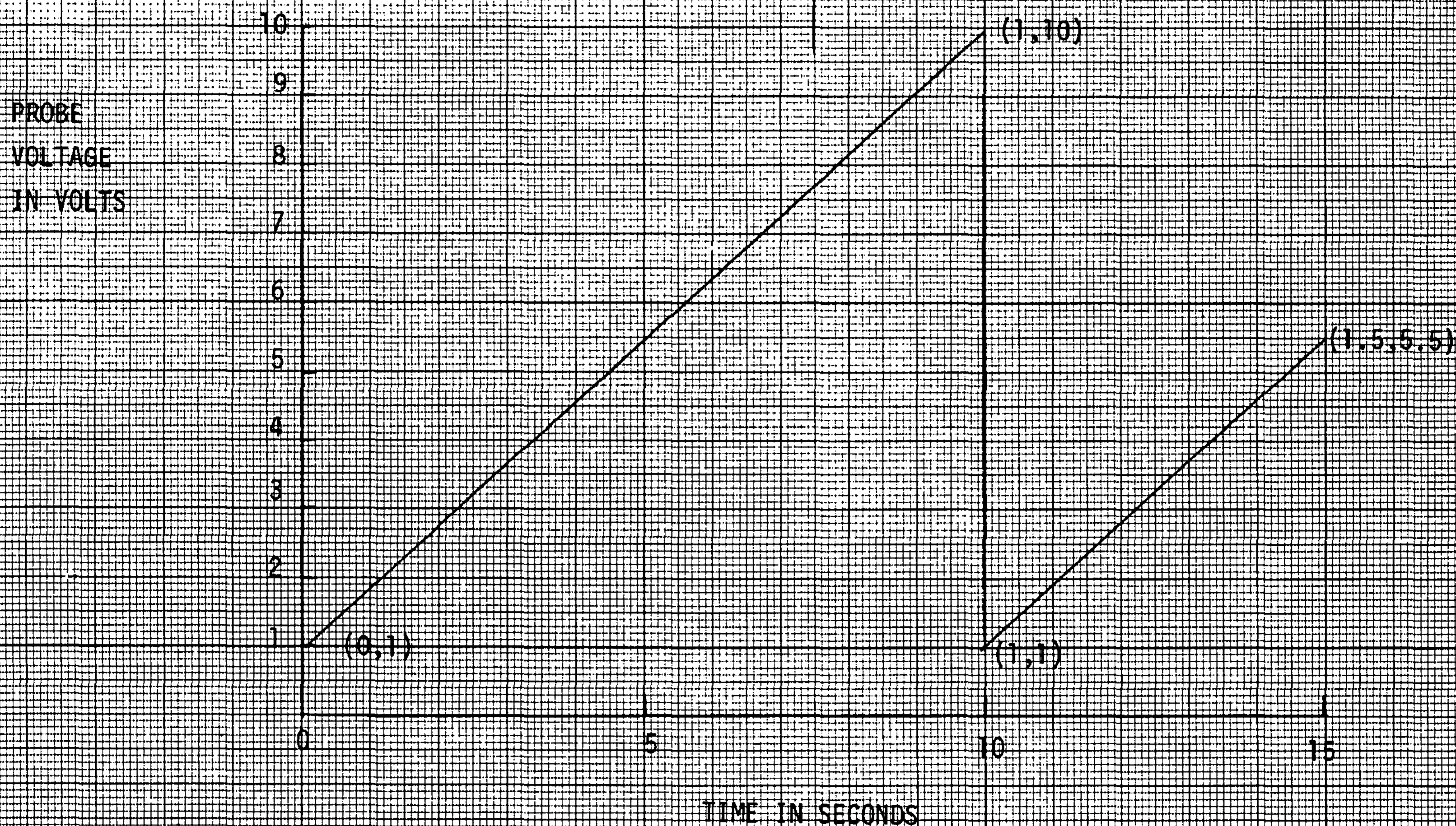
2213 SPHERICAL ION
PROBE VOLTAGE VS. TIME
(DEFAULT VALUES SHOWN)

ERROR MSG:

0: PROCEDURE
UP TO SPHERICAL ION
PROBE SETUP DISPLAY ________ UP/I/D

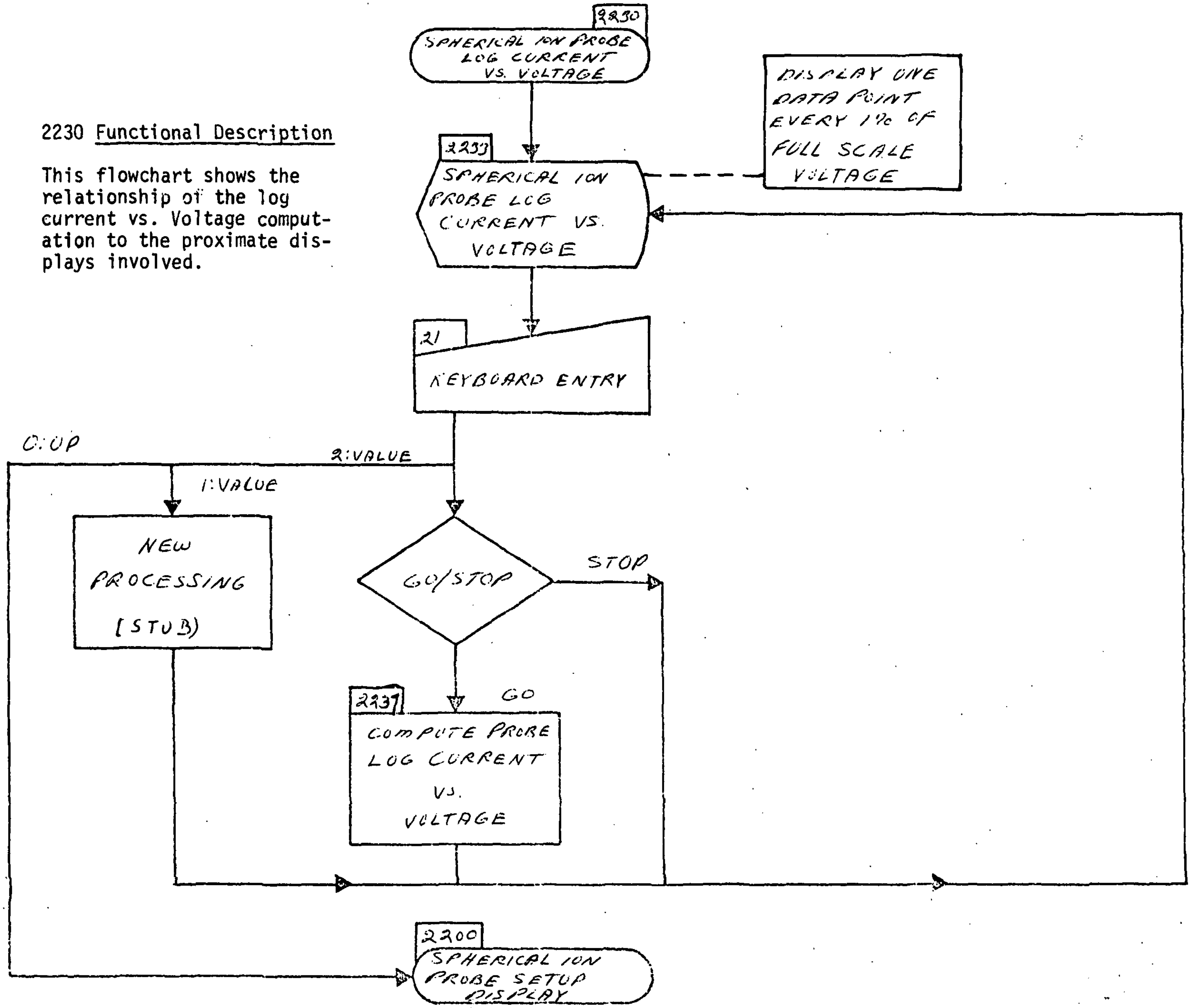
3: COMPUTE VOLTAGE VS. TIME ________ GO/STOP

2: SPARE



2230 Functional Description

This flowchart shows the relationship of the log current vs. Voltage computation to the proximate displays involved.



NOTE: ANGLE

2233 SPHERICAL ION PROBE
LOG CURRENT VS. VOLTAGE DISPLAY

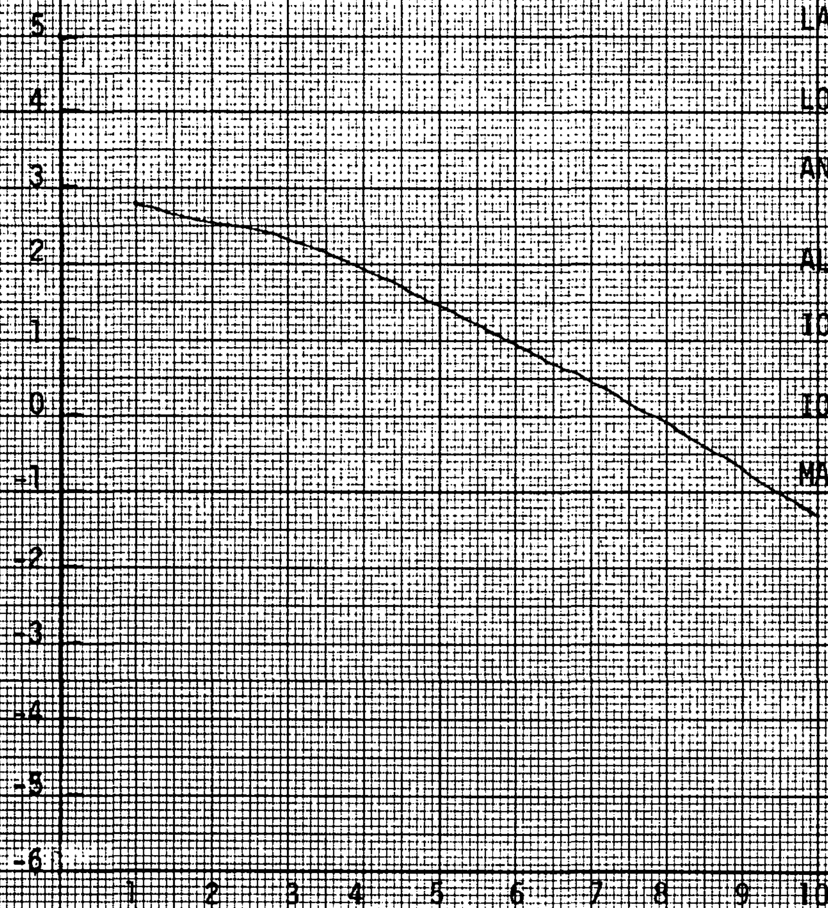
ERROR MSG:

0: PROCEDURE ________ UP/I/D
UP TO SPHERICAL ION
PROBE SETUP DISPLAY

1: SPARE

2: COMPUTE PROBE CURRENT AND ANGLE ________ GO/STOP

LOG BASE
TEN OF
PROBE
CURRENT
IN
NANOAMPS



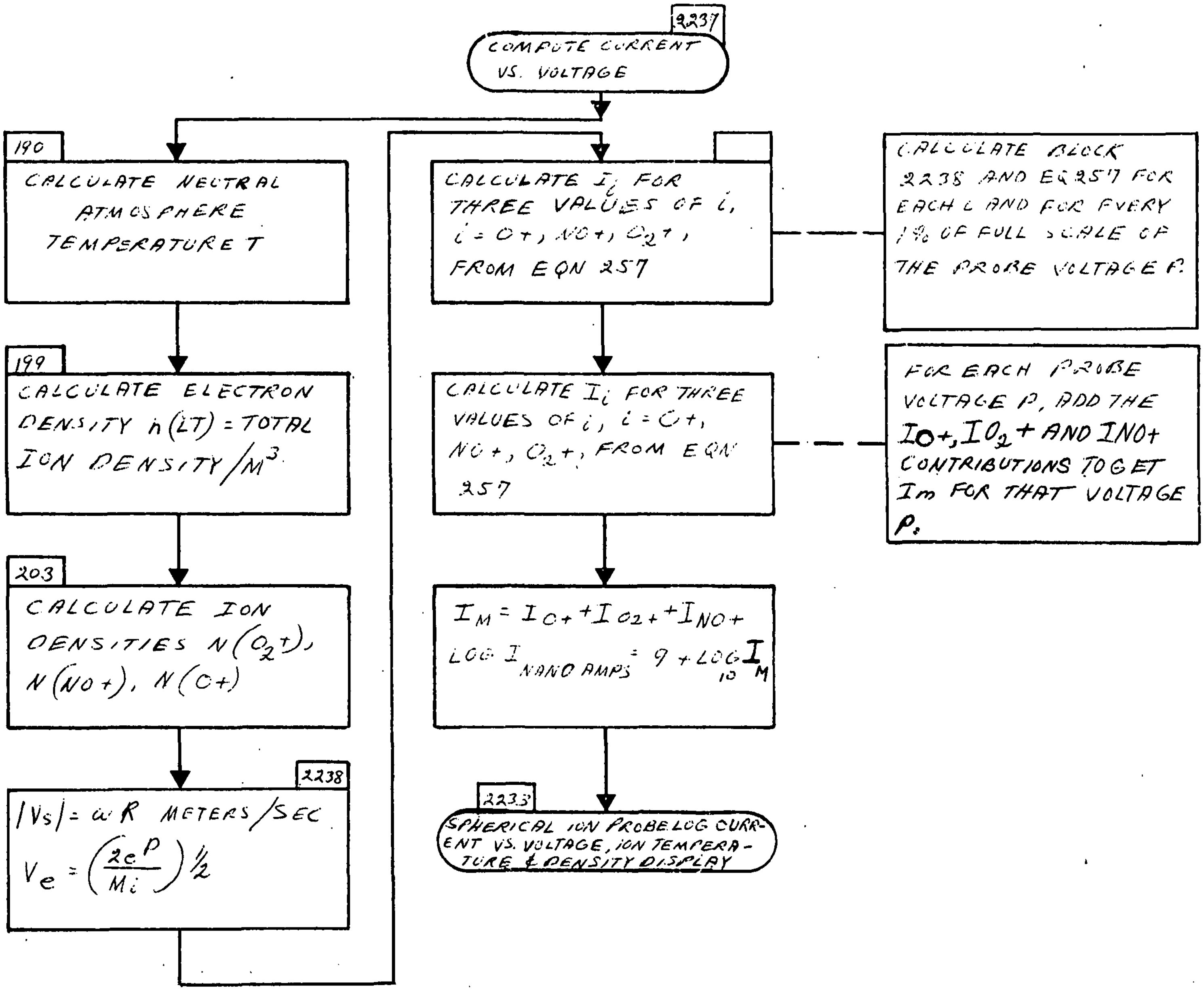
PROBE VOLTAGE IN VOLTS

LATITUDE		DEGREES
LOCAL TIME LT		HRS:MINS
ANGLE PLATFORM TO $\overline{V}$		DEGREES
ALTITUDE (H)		KM
ION TEMPERATURE		DEG K
ION DENSITY		PERM^3
MAGNETIC DIP ANGLE		DEGREES

2237 Functional Description

This flowchart shows the computation of Ion current versus Voltage based on calculated temperatures 190, electron densities 199, and average ion densities 203. This calculation requires availability of the error function integral

$$\phi(X) = \frac{2}{\sqrt{\pi}}\int^{X} e^{-t^2} dt$$ as a subroutine.



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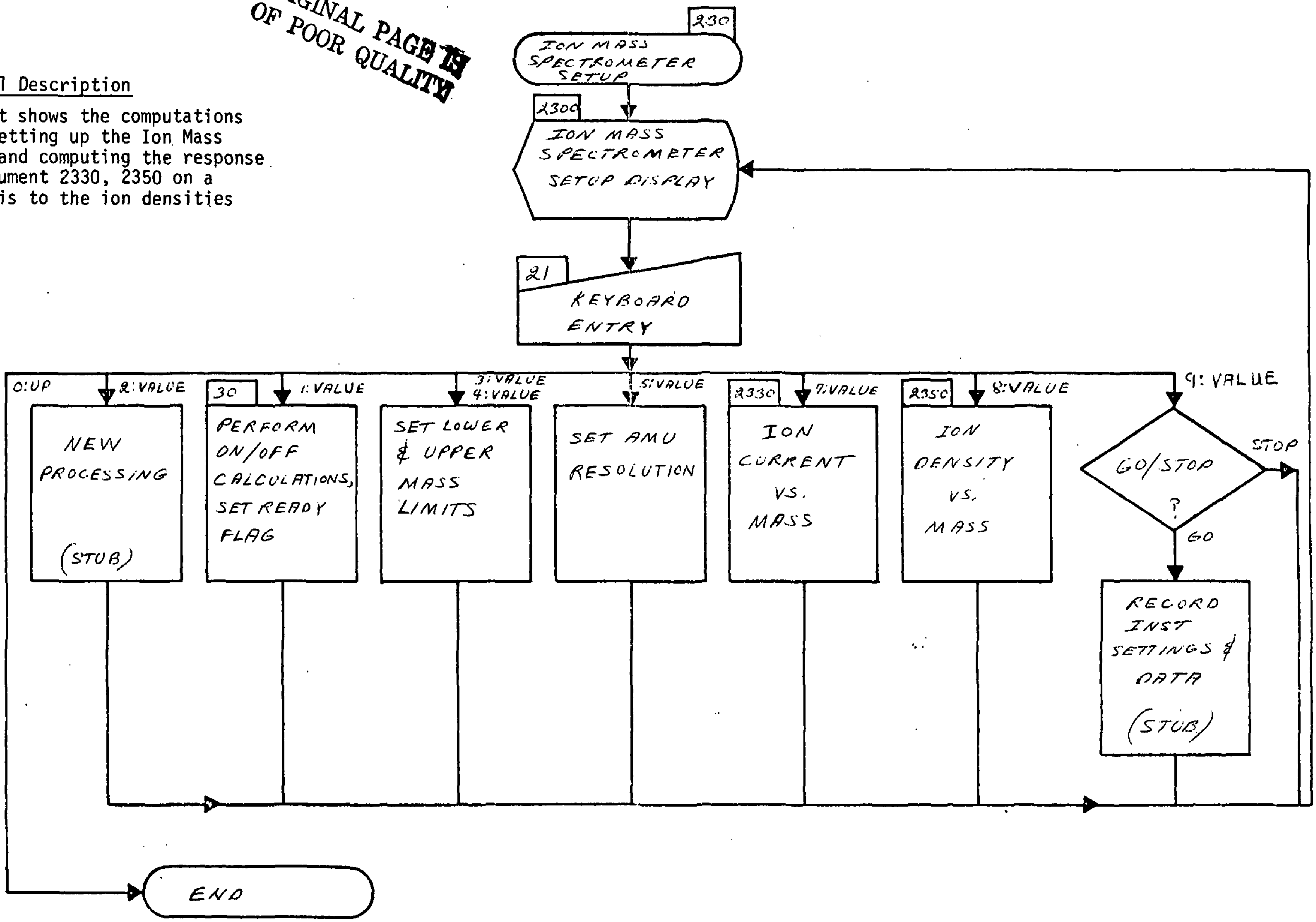
230 Functional Description

This flowchart shows the computations involved in setting up the Ion Mass Spectrometer and computing the response of this instrument 2330, 2350 on a simulated basis to the ion densities encountered.



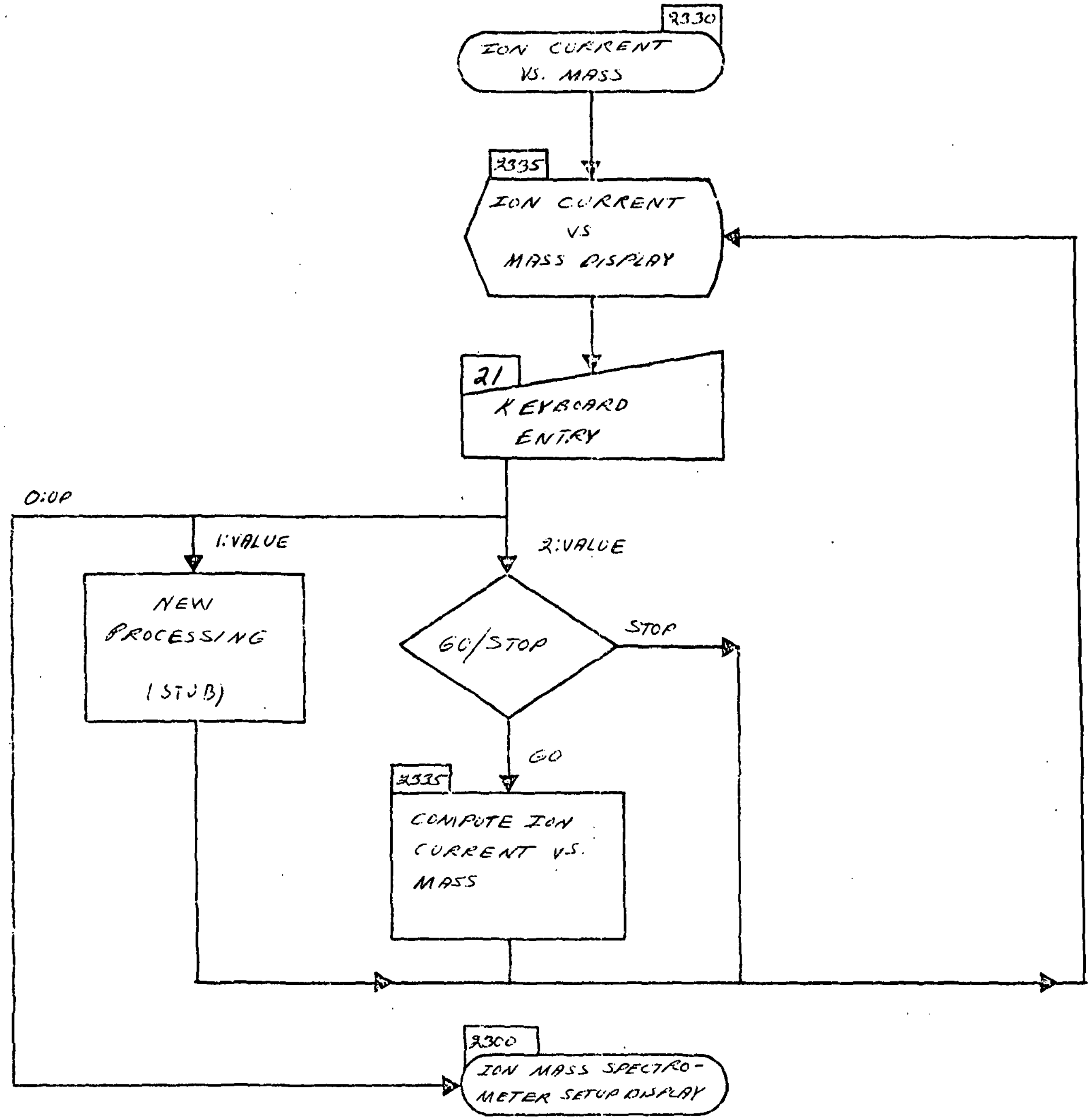
2300 ION MASS SPECTROMETER
SETUP DISPLAY

ERROR MSG:

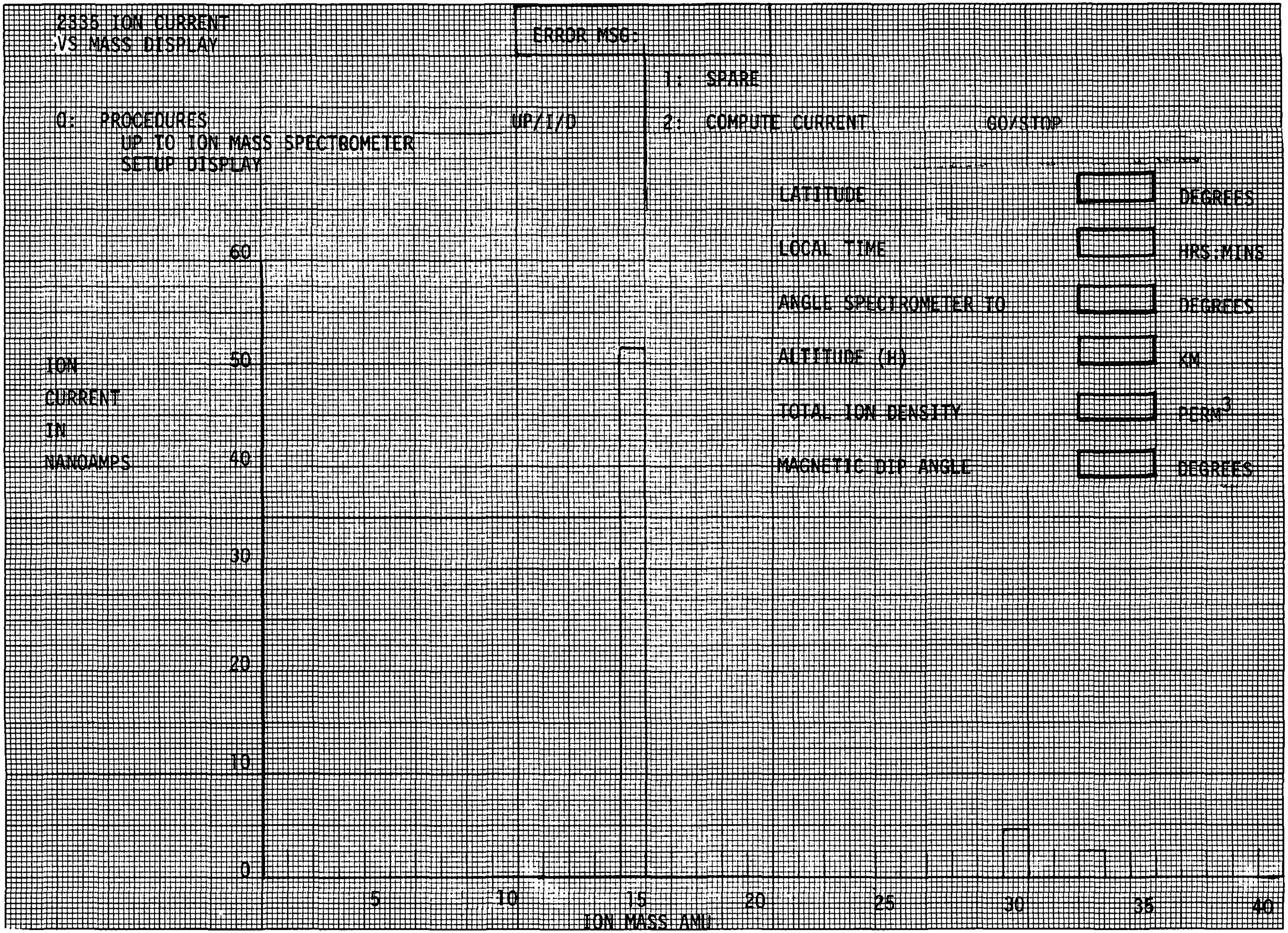
0: PROCEDURE UP TO ________	____	UP/I/D
1: ION MASS SPECTROMETER	____	ON/OFF
	☐	READY
2: SPARE		
3: SET LOWER MASS LIMIT	____	XX AMU
4: SET UPPER MASS LIMIT	____	XX AMU
5: SET RESOLUTION	____	XX AMU
6: SPARE		
7: DISPLAY ION CURRENT VS MASS	____	I/NO
8: DISPLAY ION DENSITY VS MASS	____	I/NO
9: RECORD INSTRUMENT SETTINGS AND DATA	____	GO/STOP

2330
<u>Functional Description</u>

This flowchart shows the relationship of the Ion Current vs. Mass computation to the proximate displays involved.

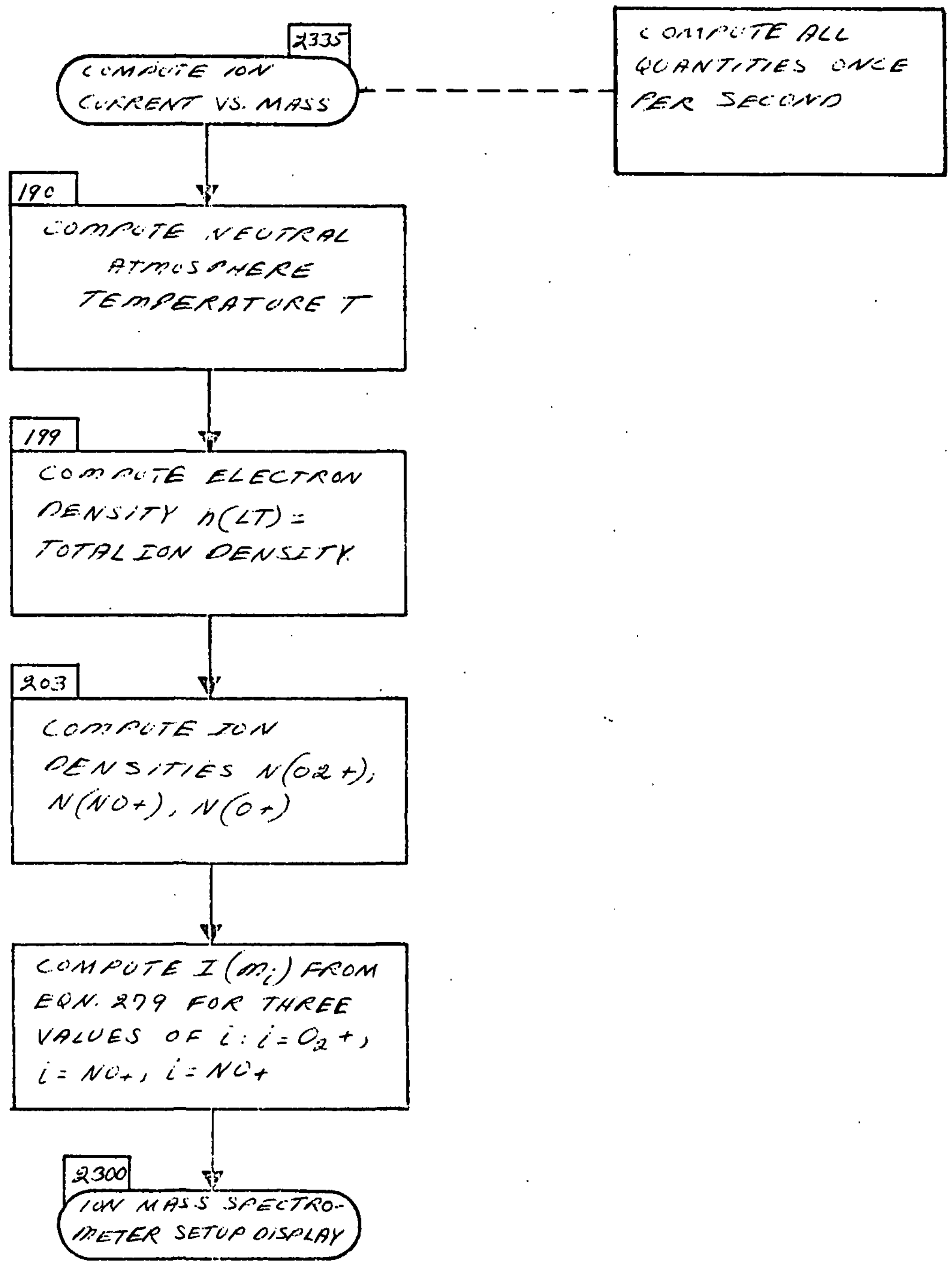


NOTE: ANGLE SPECTROMETER TO $\overline{V}$ GIVEN BY EQN. 218



2335 Functional Description

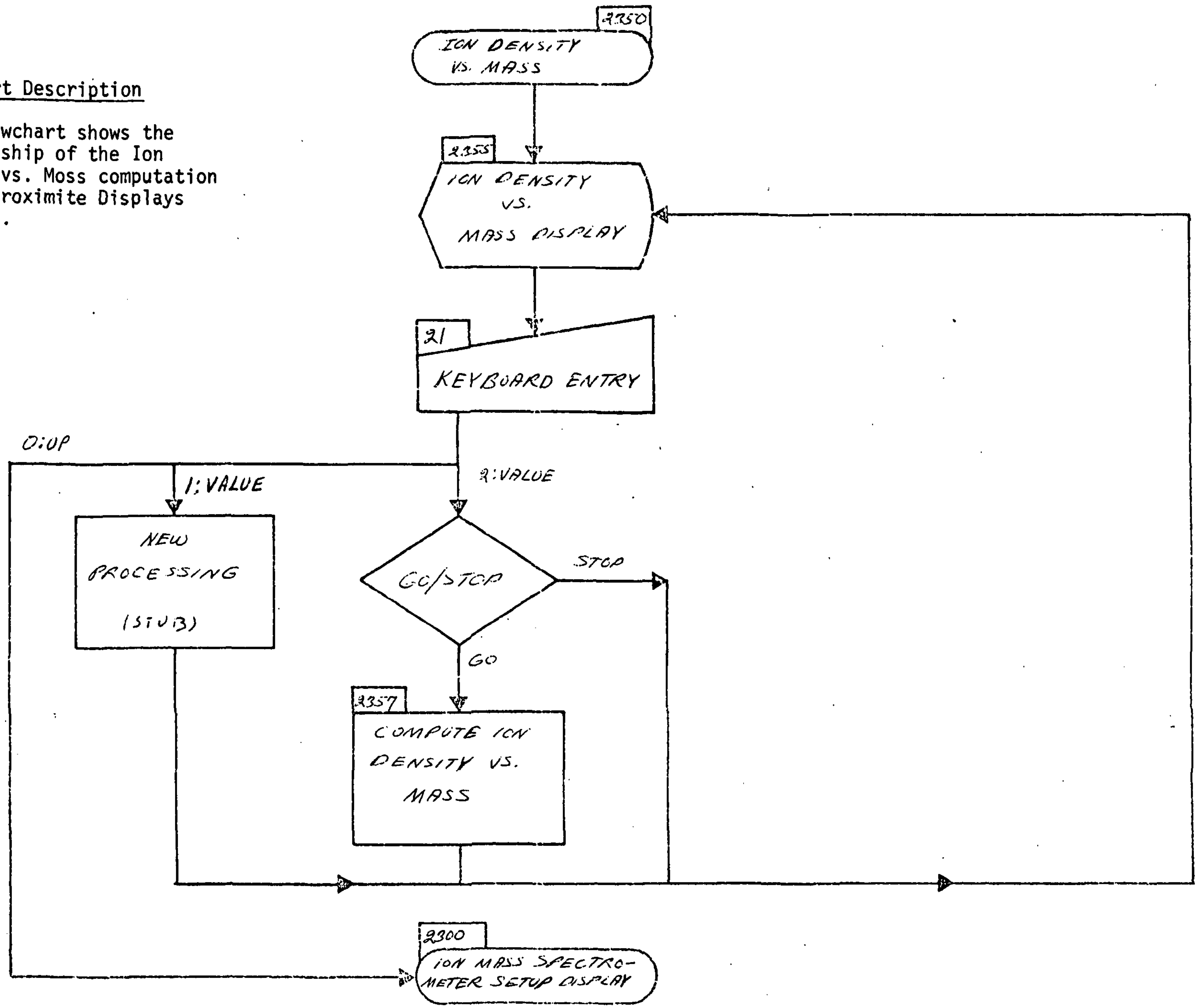
This flowchart shows the computation of Ion Current versus Mass. Ion Currents depend on quantities of density and temperature which are calculated from previously defined subroutines.



2350

Flowchart Description

This flowchart shows the relationship of the Ion Density vs. Moss computation to the proximite Displays involved.



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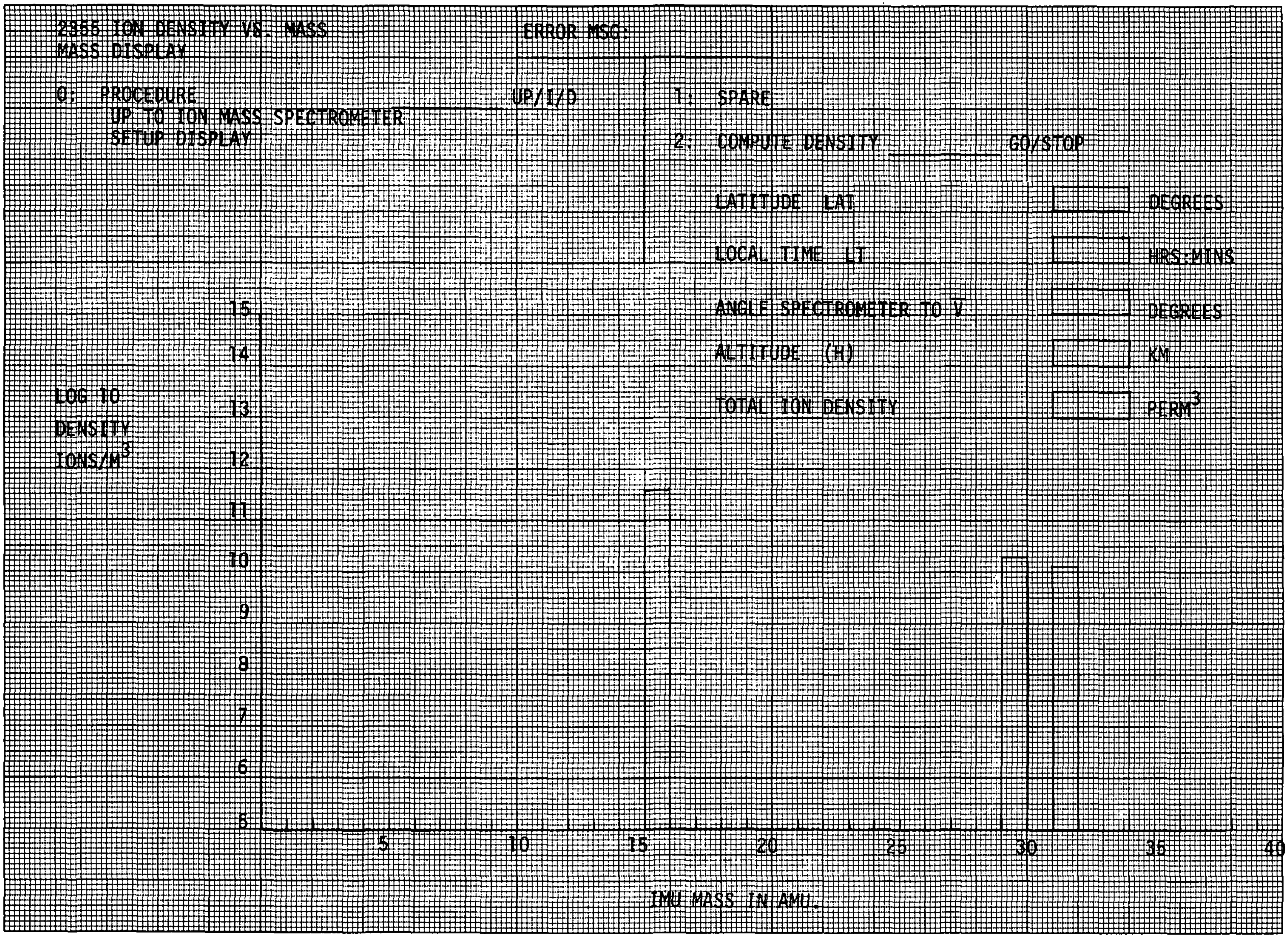
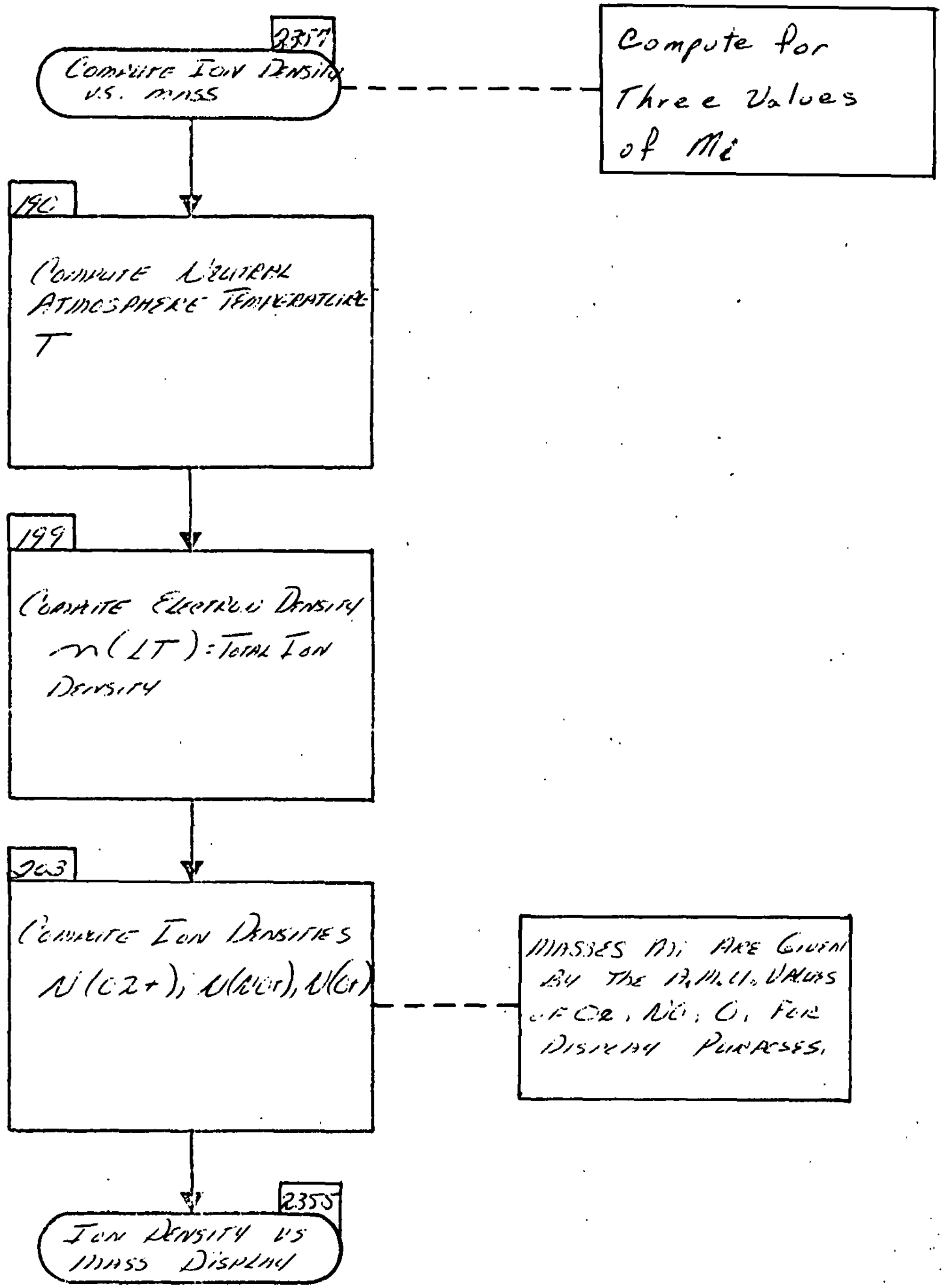
NOTE: ANGLE SPECTROMETER TO $\bar{V}$ GIVEN BY EQN. 218



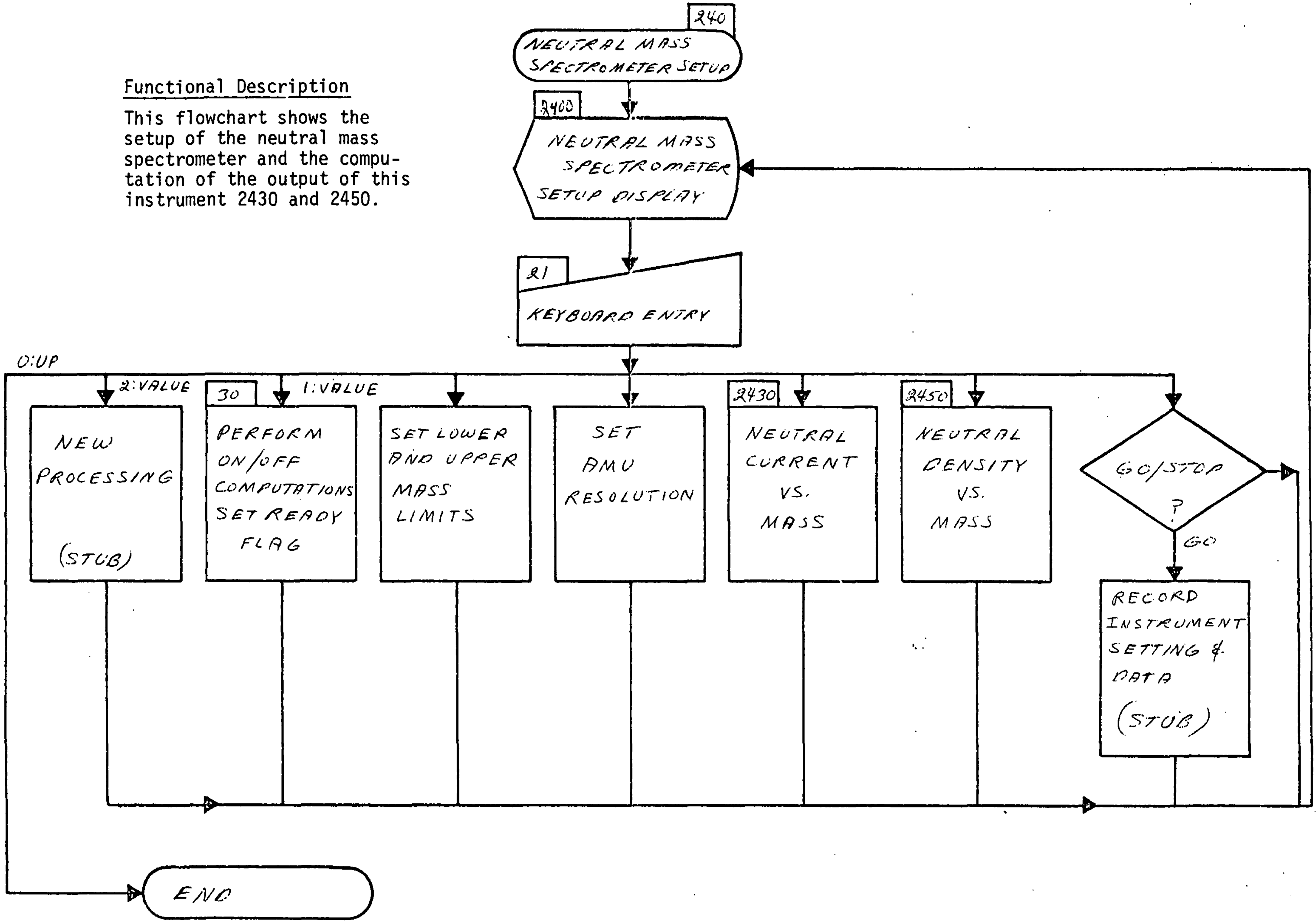
2357 Functional Description

This flowchart shows the computation of Ion Densities of three species of ions. These densities are based on total electron density and temperature computations done by previously defined subroutines.



Functional Description

This flowchart shows the setup of the neutral mass spectrometer and the computation of the output of this instrument 2430 and 2450.



2400 NEUTRAL MASS SPECTROMETER
SETUP DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO ____________________
____

1: NEUTRAL MASS SPECTROMETER ______ ON/OFF

READY

2: SPARE

3: SET UPPER MASS LIMIT ______ XX AMU

4: SET LOWER MASS LIMIT ______ XX AMU

5: SET RESOLUTION ______ XX AMU

6: SPARE

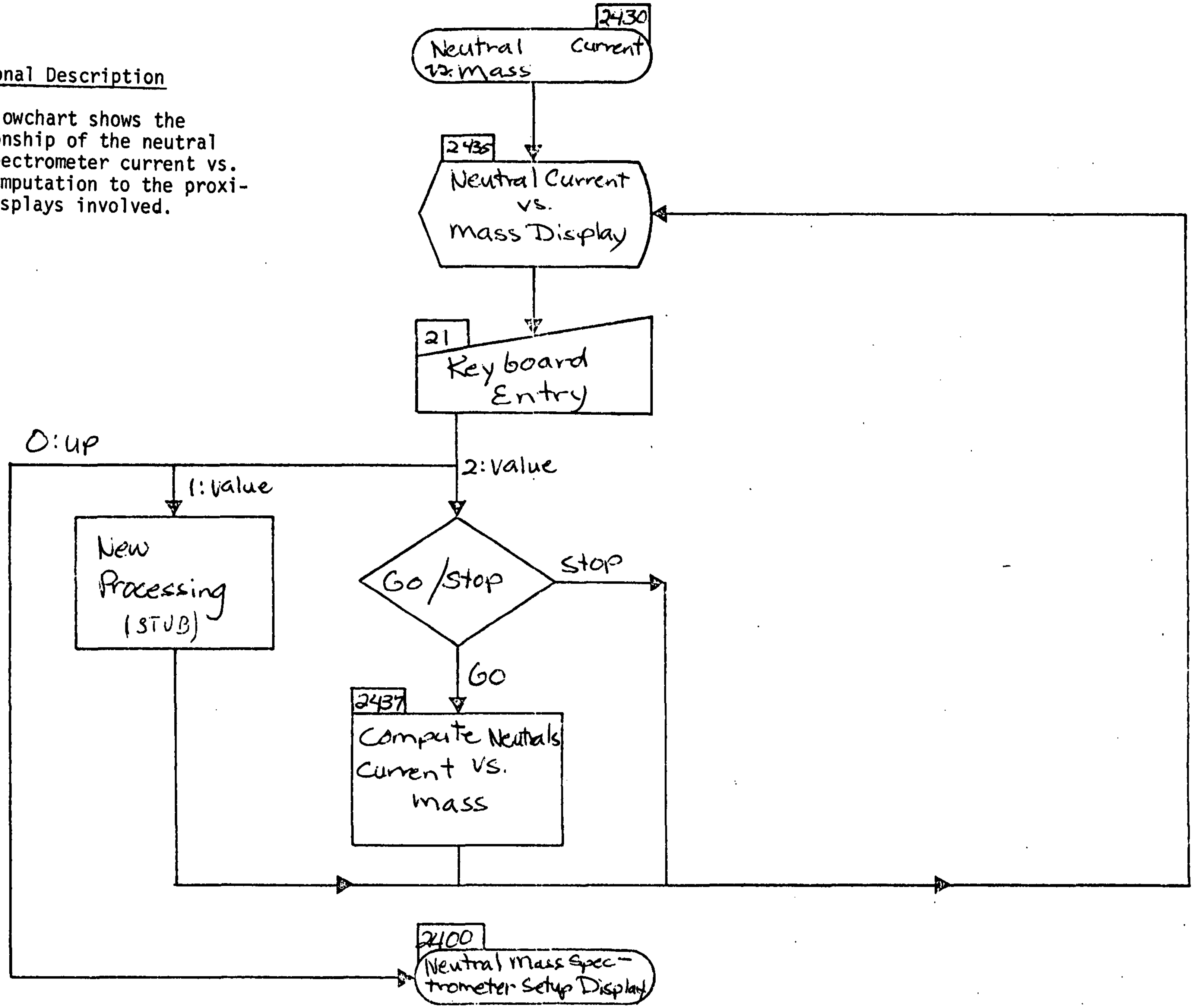
7: DISPLAY NEUTRAL CURRENT VS MASS ______ I/NO

8: DISPLAY NEUTRAL DENSITY VS MASS ______ I/NO

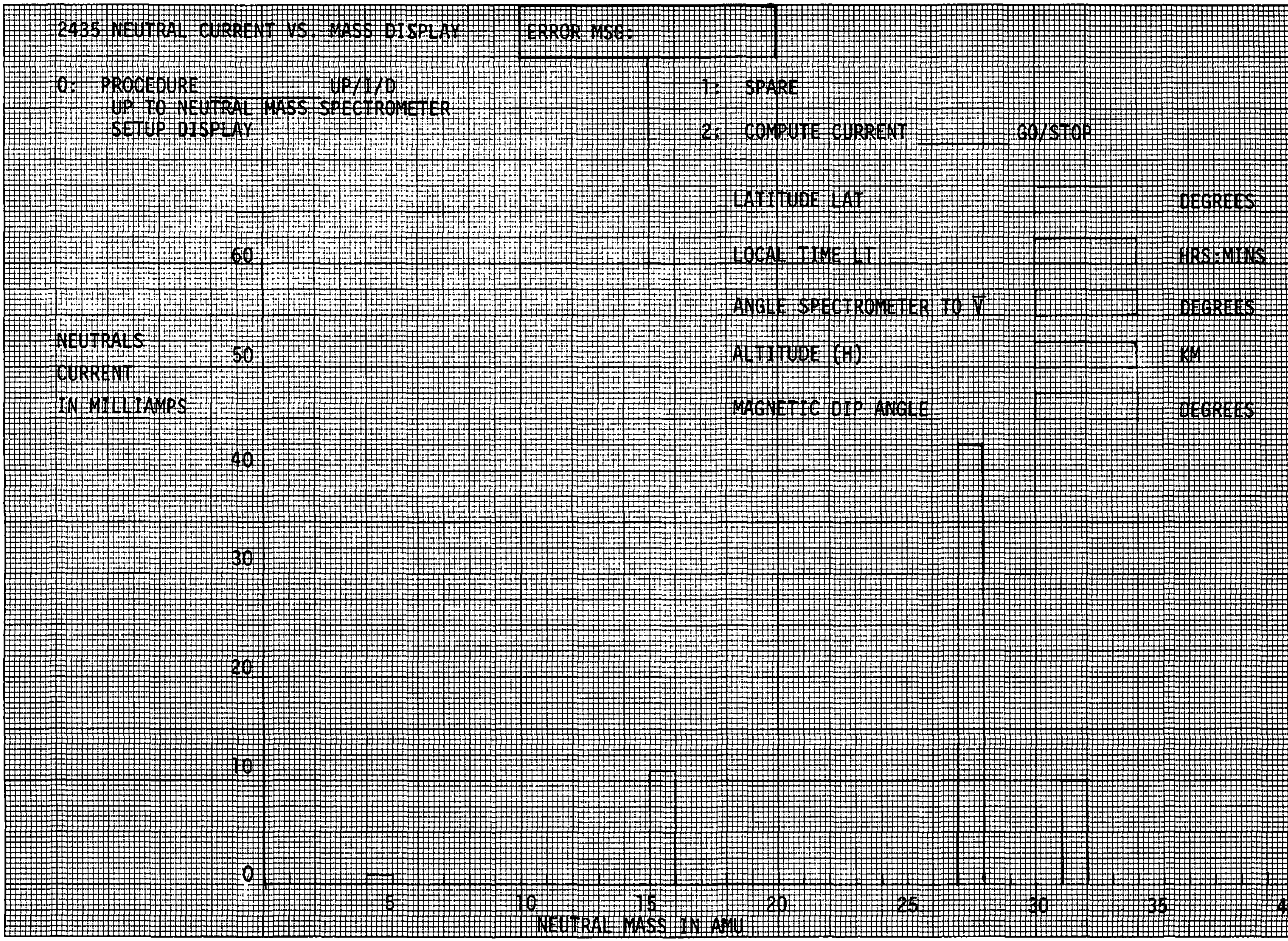
9: RECORD INSTRUMENT SETTINGS AND DATA ______ GO/STOP

Functional Description

This flowchart shows the relationship of the neutral mass spectrometer current vs. mass computation to the proximate displays involved.

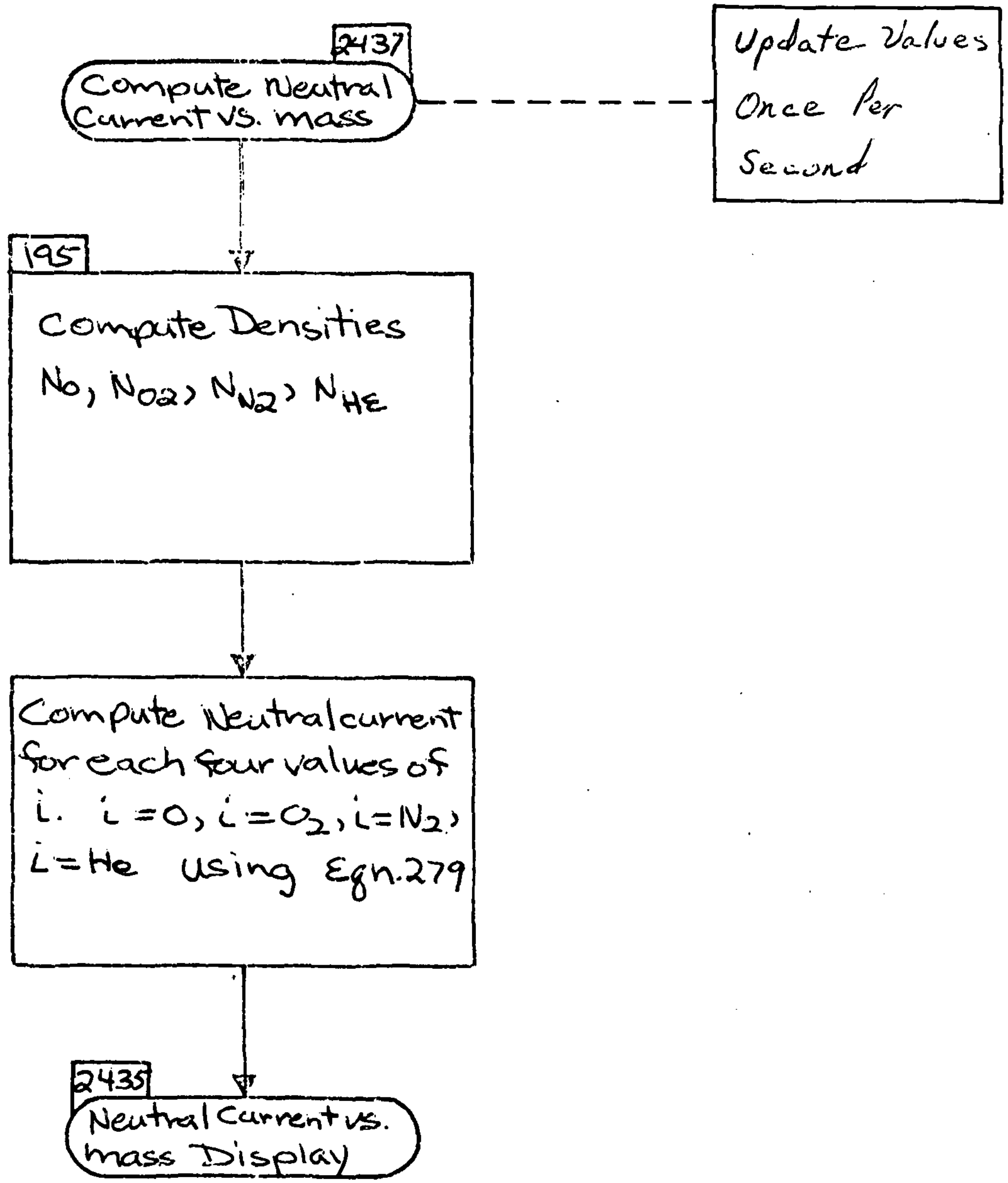


NOTE: ANGLE SPECTROMETER TO $\overline{V}$ GIVEN BY EQN. 218



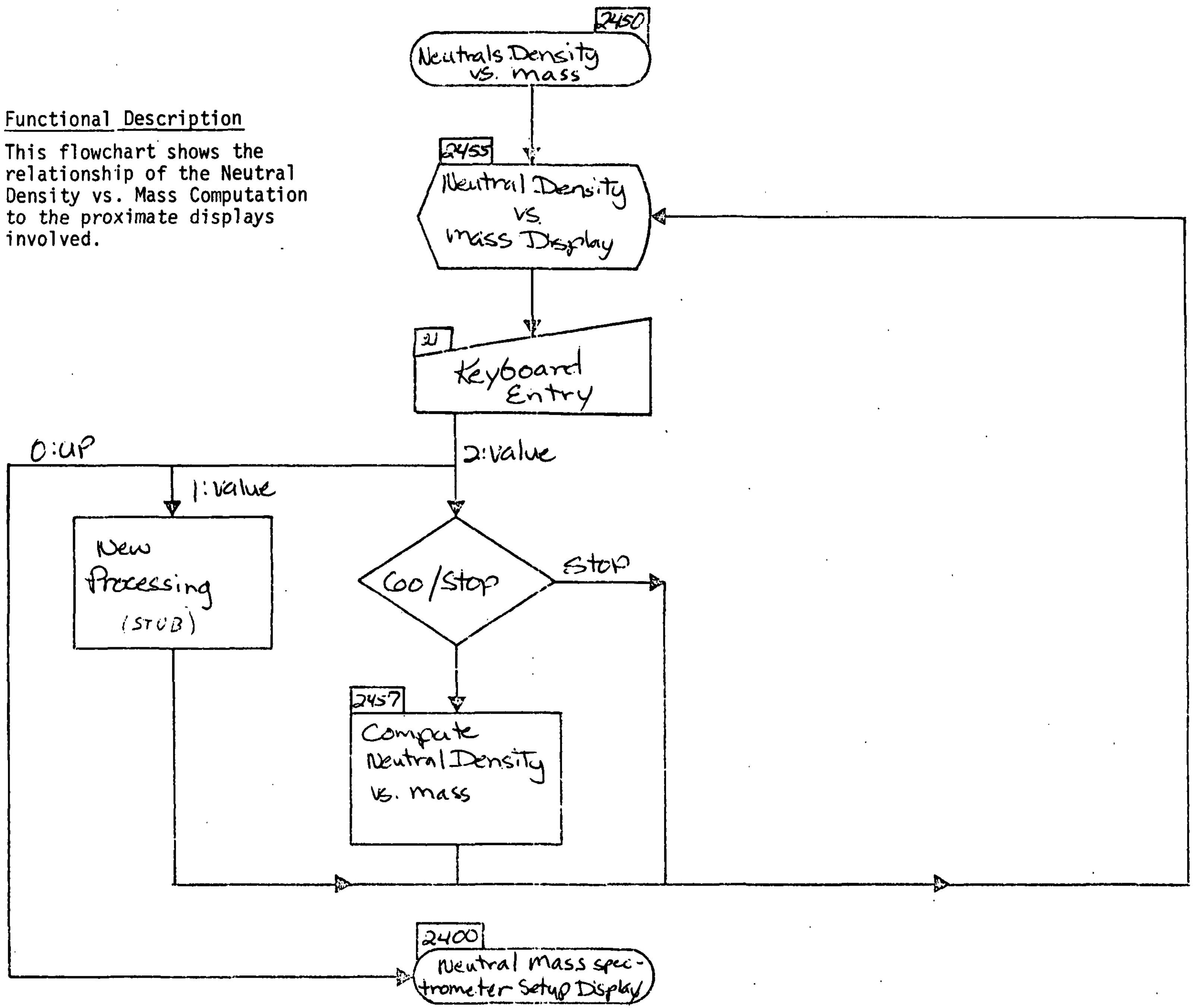
Functional Description

This flowchart shows the computation of spectrometer current, which depends on subroutine 195 outputs of neutral particle density computations.



Functional Description

This flowchart shows the relationship of the Neutral Density vs. Mass Computation to the proximate displays involved.



NOTE: ANGLE SPECTROMETER TO $\overline{V}$ IS GIVEN BY EQN. 218

2455 NEUTRAL DENSITY VS. MASS DISPLAY

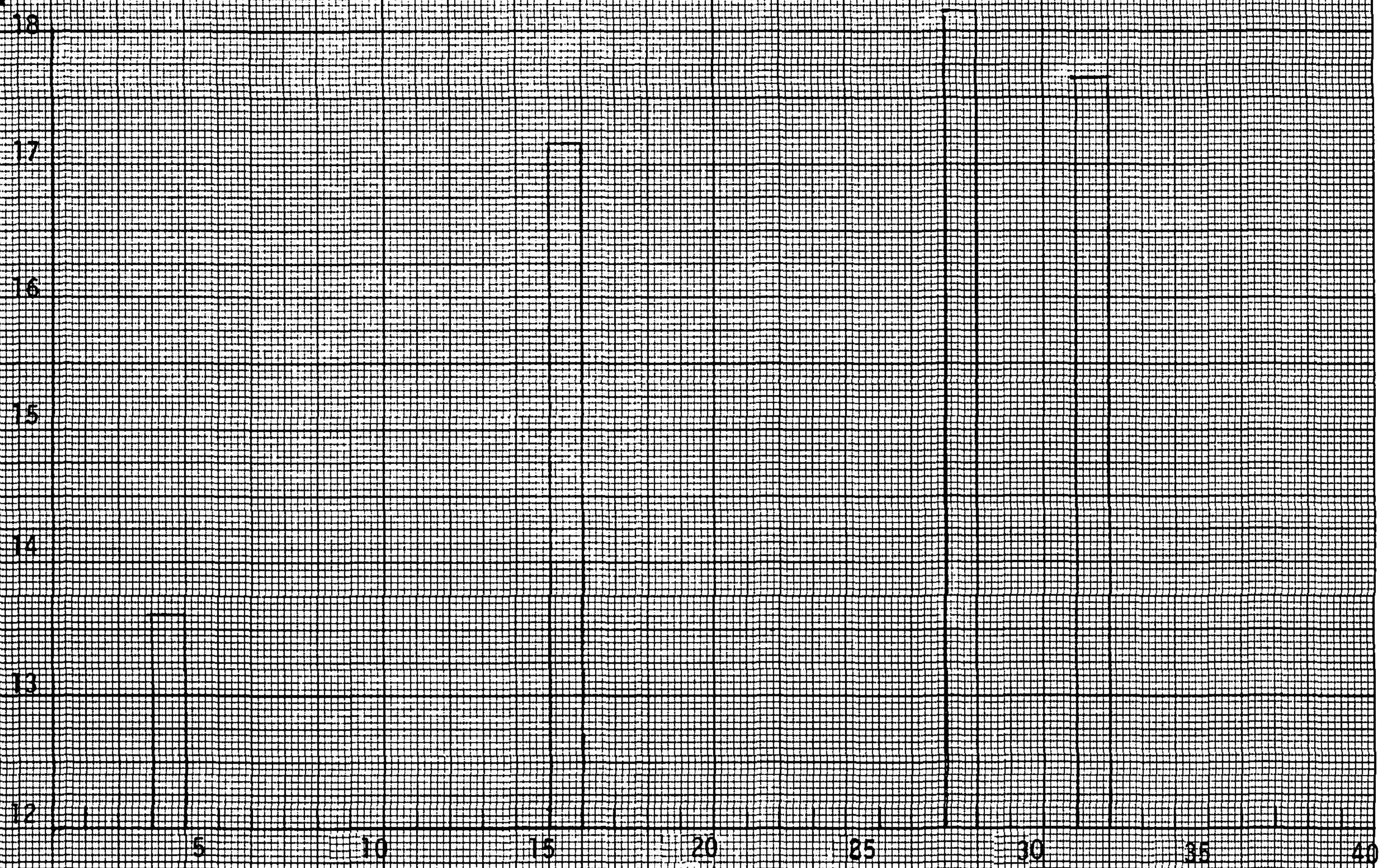
ERROR MSG:

0: PROCEDURE UP/I/D
UP TO NEUTRAL MASS SPECTROMETER
SETUP DISPLAY

1: SPARE

2: COMPUTE DENSITY ________ GO/STOP

LOG 10
NEUTRALS DENSITY
PER M^3



LATITUDE LAT
DEGREES

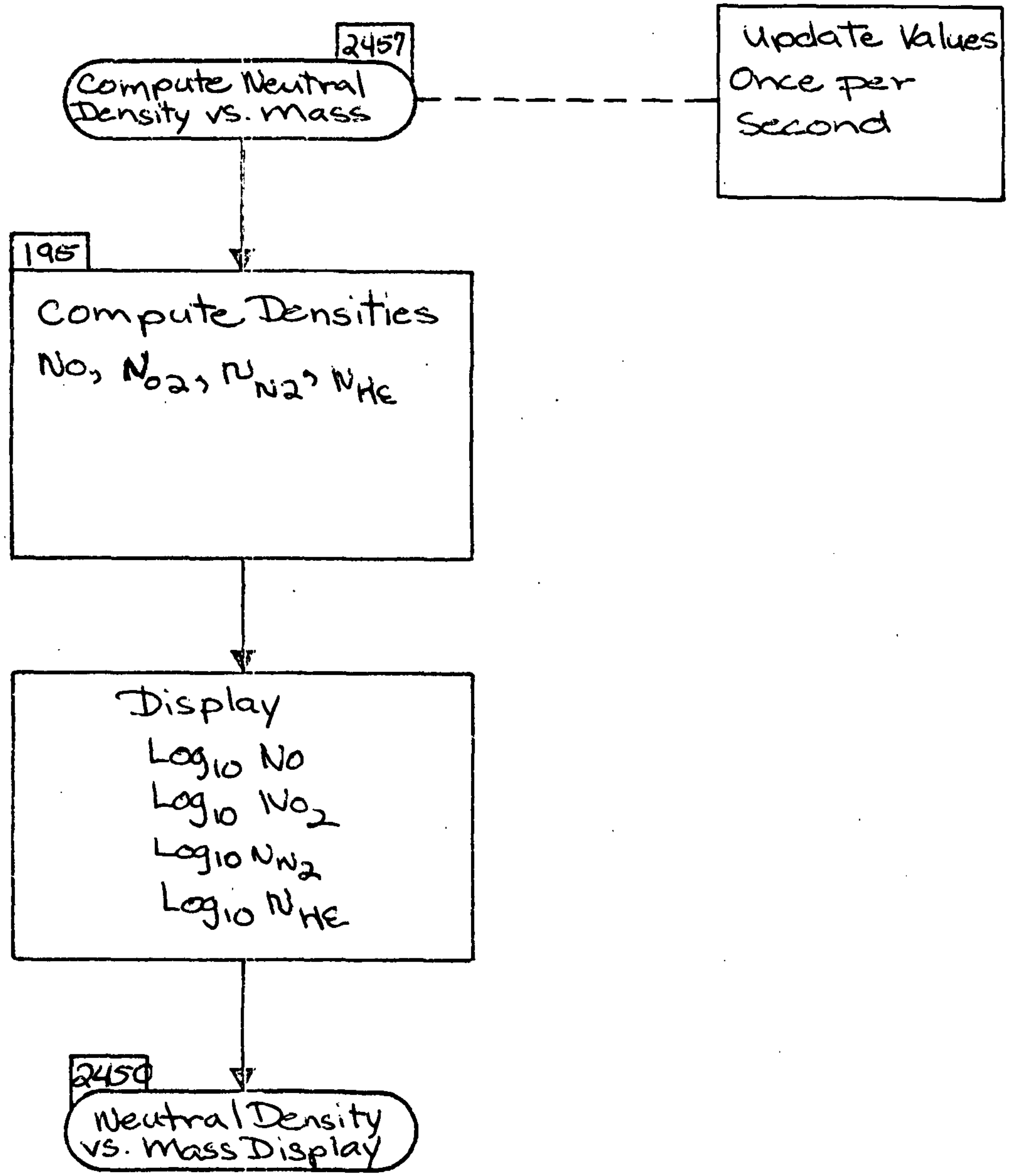
LOCAL TIME
HRS:MINS

ANGLE SPECTROMETER TO V
DEGREES

ALTITUDE
KM

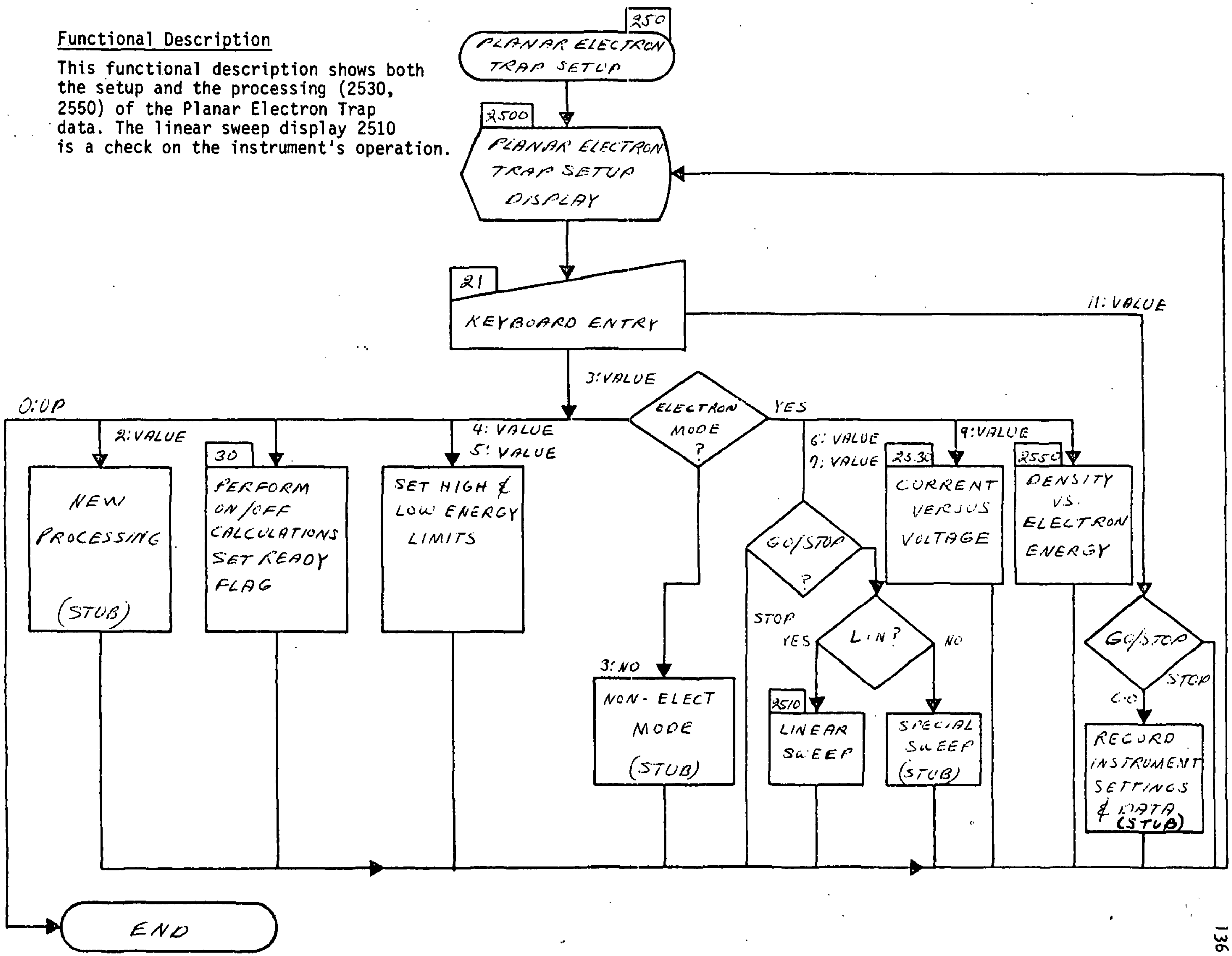
Functional Description

This flowchart shows the computation of the logarithm of the Densities of the neutral particles, based on the outputs of the subroutine density 195 calculations



Functional Description

This functional description shows both the setup and the processing (2530, 2550) of the Planar Electron Trap data. The linear sweep display 2510 is a check on the instrument's operation.



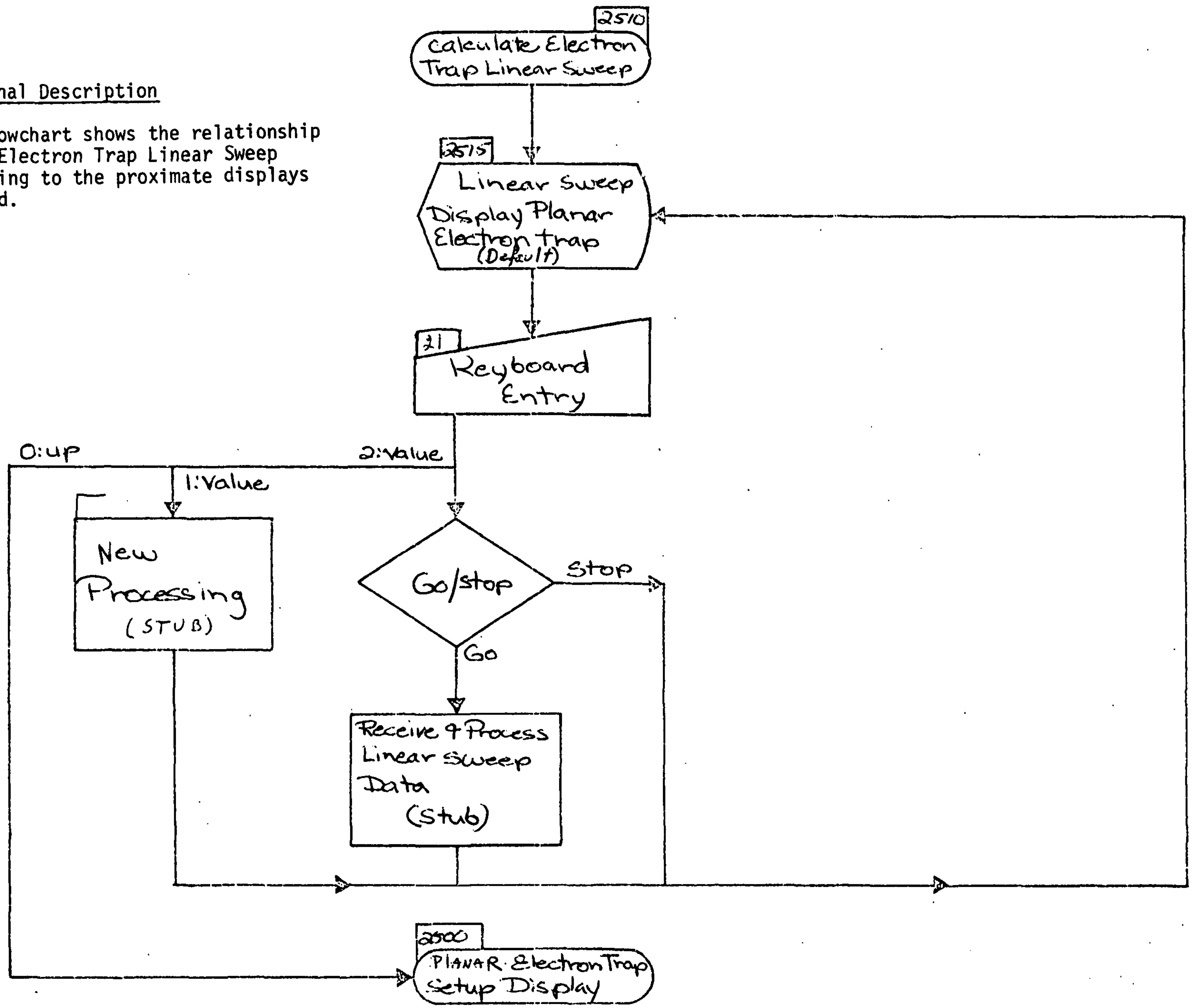
2500 PLANAR ELECTRON
TRAP SETUP DISPLAY

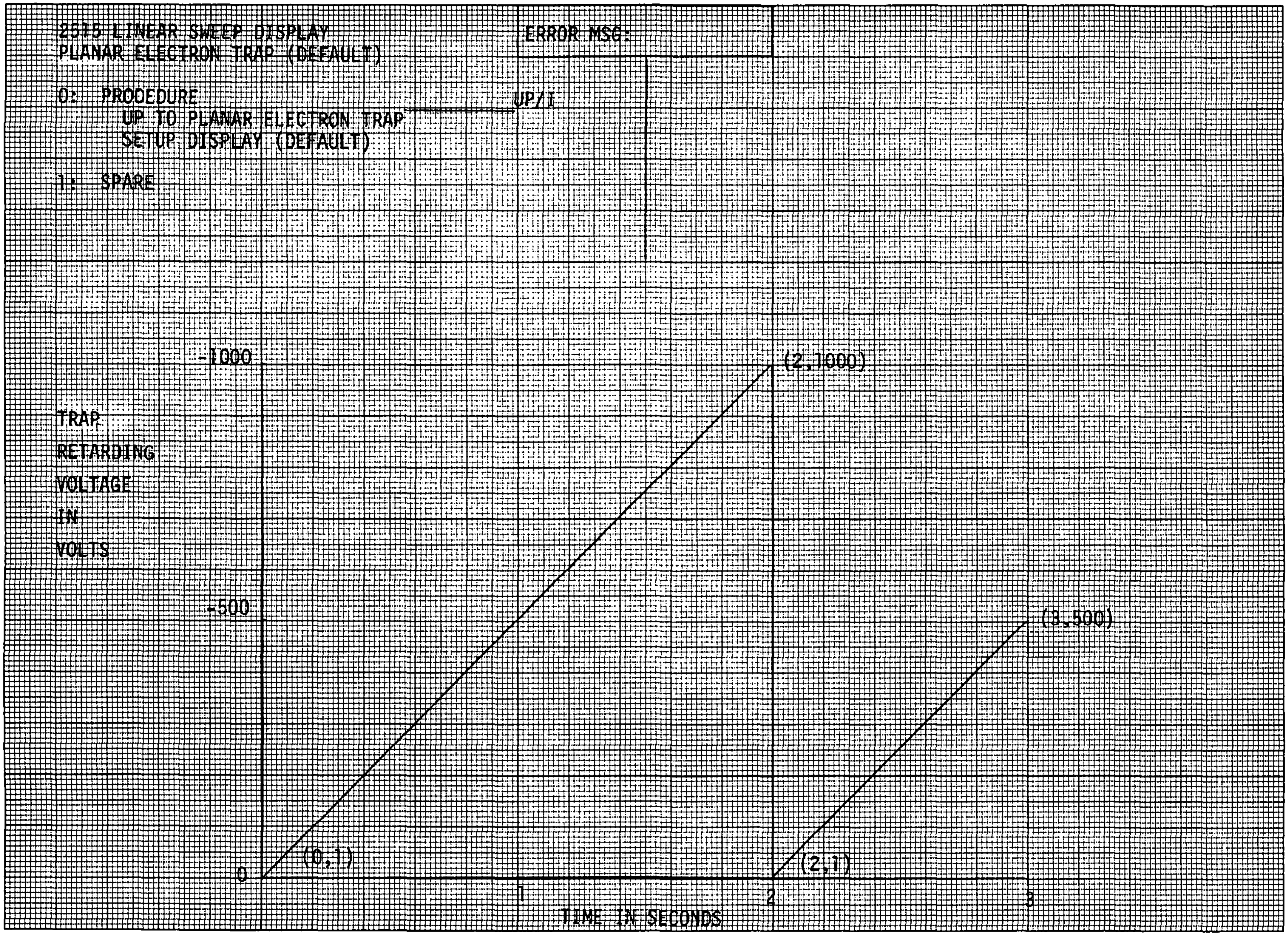
ERROR MSG:

0: PROCEDURE UP TO ________ ________	____	UP/I/D
1: PLANAR ELECTRON TRAP	____	ON/OFF
	☐	READY
2: SPARE		
3: SET TRAP IN ELECTRON MODE	____	YES/NO
4: SET HIGH ENERGY LIMIT	____	XXXX.eV
5: LET LOW ENERGY LIMIT	____	XXXX.eV
6: SET SWEEP MODE	____	LIN/SPECIAL
7: DISPLAY LINEAR SWEEP	____	GO/STOP
8: SPARE		
9: DISPLAY CURRENT VS VOLTAGE	____	I/NO
10: DISPLAY DENSITY VS ENERGY	____	I/NO
11: RECORD SETTINGS AND DATA	____	GO/STOP

Functional Description

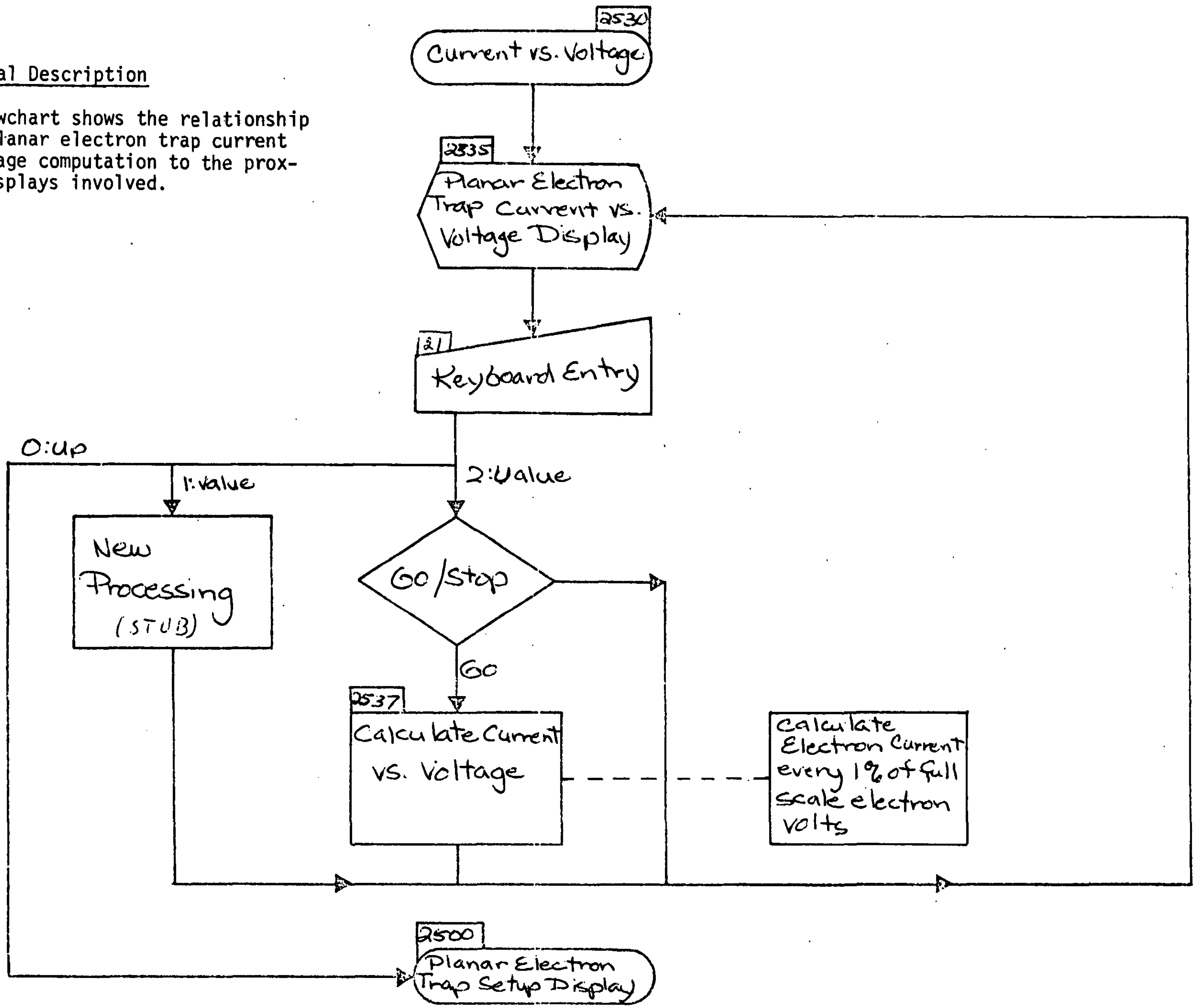
This flowchart shows the relationship of the Electron Trap Linear Sweep processing to the proximate displays involved.




2515 LINEAR SWEEP DISPLAY
PLANAR ELECTRON TRAP (DEFAULT)
ERROR MSG:
0: PROCEDURE
UP TO PLANAR ELECTRON TRAP
SETUP DISPLAY (DEFAULT)
UP/I
1: SPARE
TRAP
RETARDING
VOLTAGE
IN
VOLTS
-1000
-500
0
(0,1)
(2,1000)
(2,1)
(3,500)
1
2
3
TIME IN SECONDS

Functional Description

This flowchart shows the relationship of the planar electron trap current vs. voltage computation to the proximate displays involved.



2535 PLANAR ELECTRON TRAP
CURRENT VS. VOLTAGE DISPLAY

ERROR MSG:

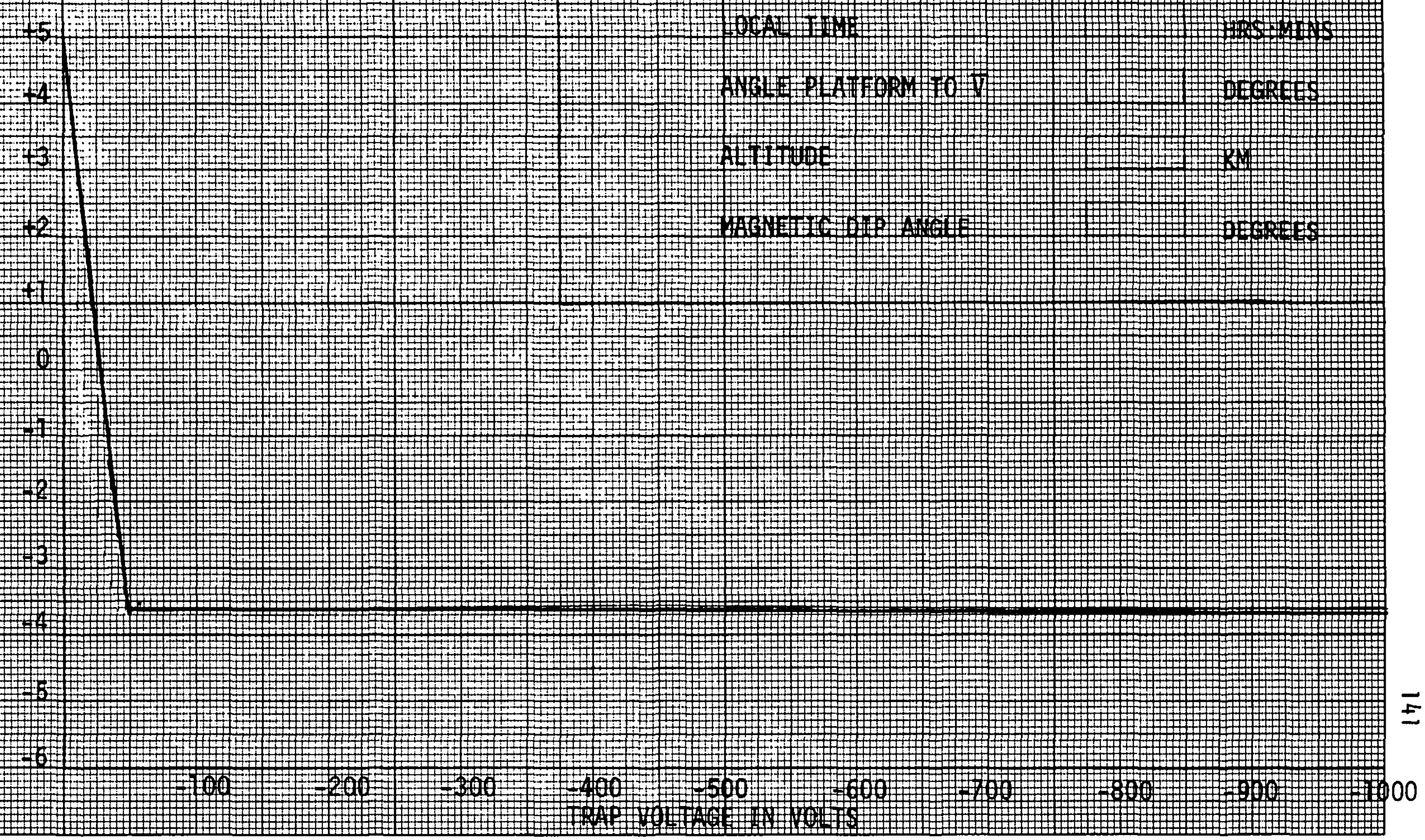
0: PROCEDURE ________ UP/I/D
UP TO PLANAR ELECTRON TRAP SETUP DISPLAY

1: SPARE

2: CALCULATE CURRENT VS. VOLTAGE ________ GO/STOP

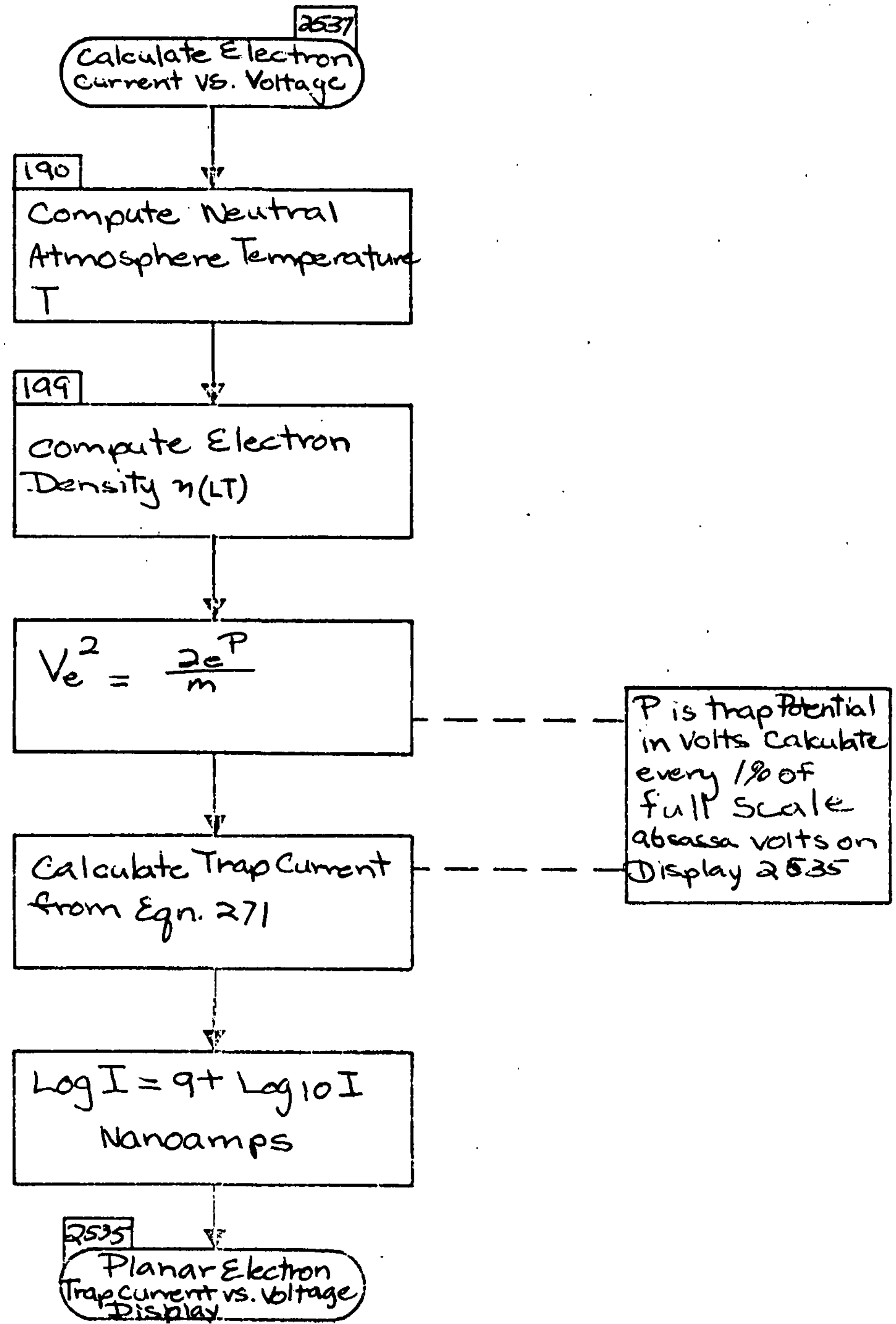
ELECTRON TEMPERATURE		KELVIN
ELECTRON VOLTS		VOLTS
ELECTRON DENSITY		PER M^3
LATITUDE		DEGREES
LOCAL TIME		HRS:MINS
ANGLE PLATFORM TO $\bar{V}$		DEGREES
ALTITUDE		KM
MAGNETIC DIP ANGLE		DEGREES

LOG 10
TRAP
CURRENT
NANOAMPS



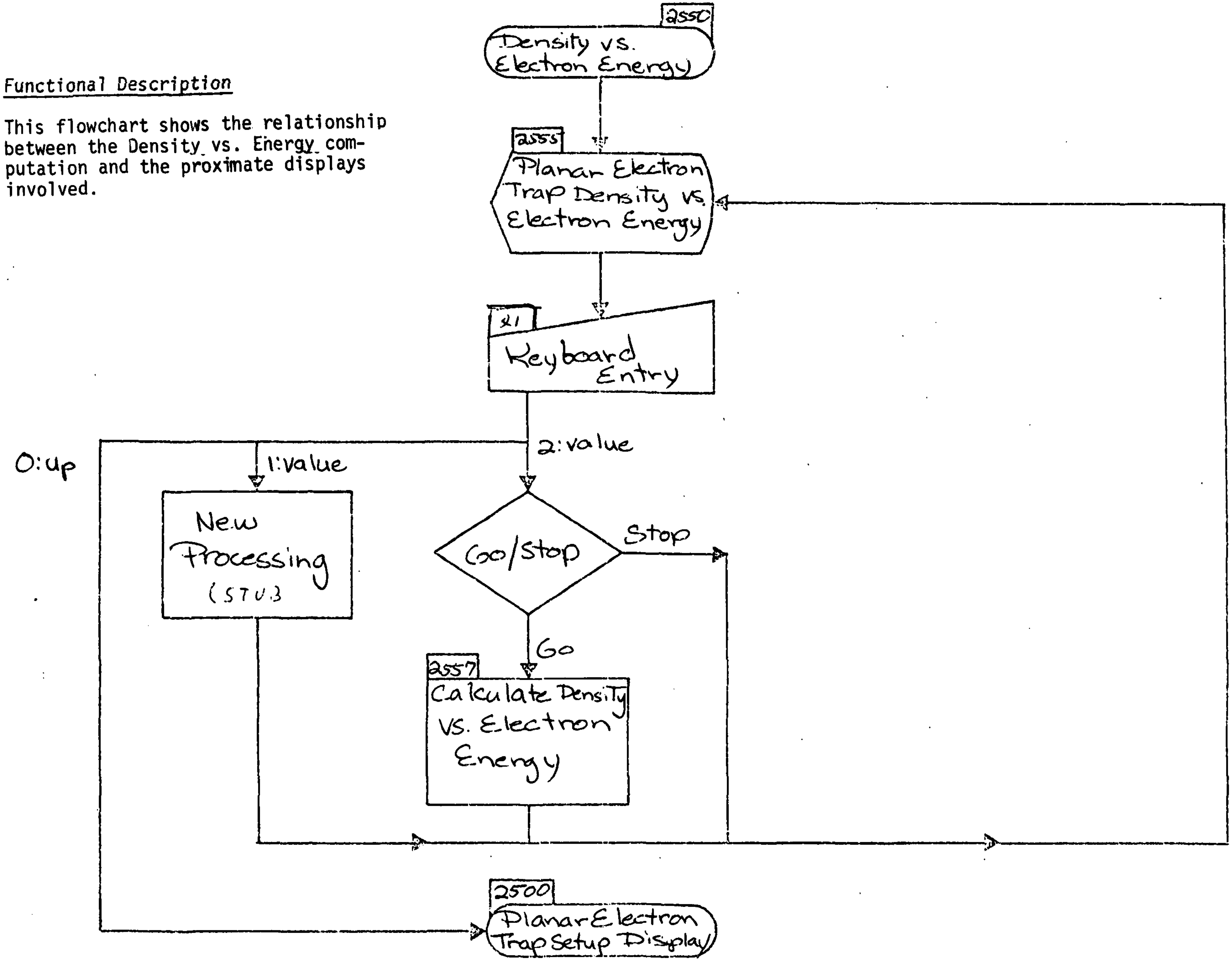
Functional Description

This flowchart shows the computation of Electron current based on the temperatures computed by subroutine 190 and the densities computed by subroutine 199.



Functional Description

This flowchart shows the relationship between the Density vs. Energy computation and the proximate displays involved.



2555 PLANAR ELECTRON TRAP
DENSITY VS. ELECTRON ENERGY DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO PLANAR ELECTRON TRAP SETUP DISPLAY

1: SPARE

2: CALCULATE DENSITY IN ELECTRON ENERGY ____ GO/STOP

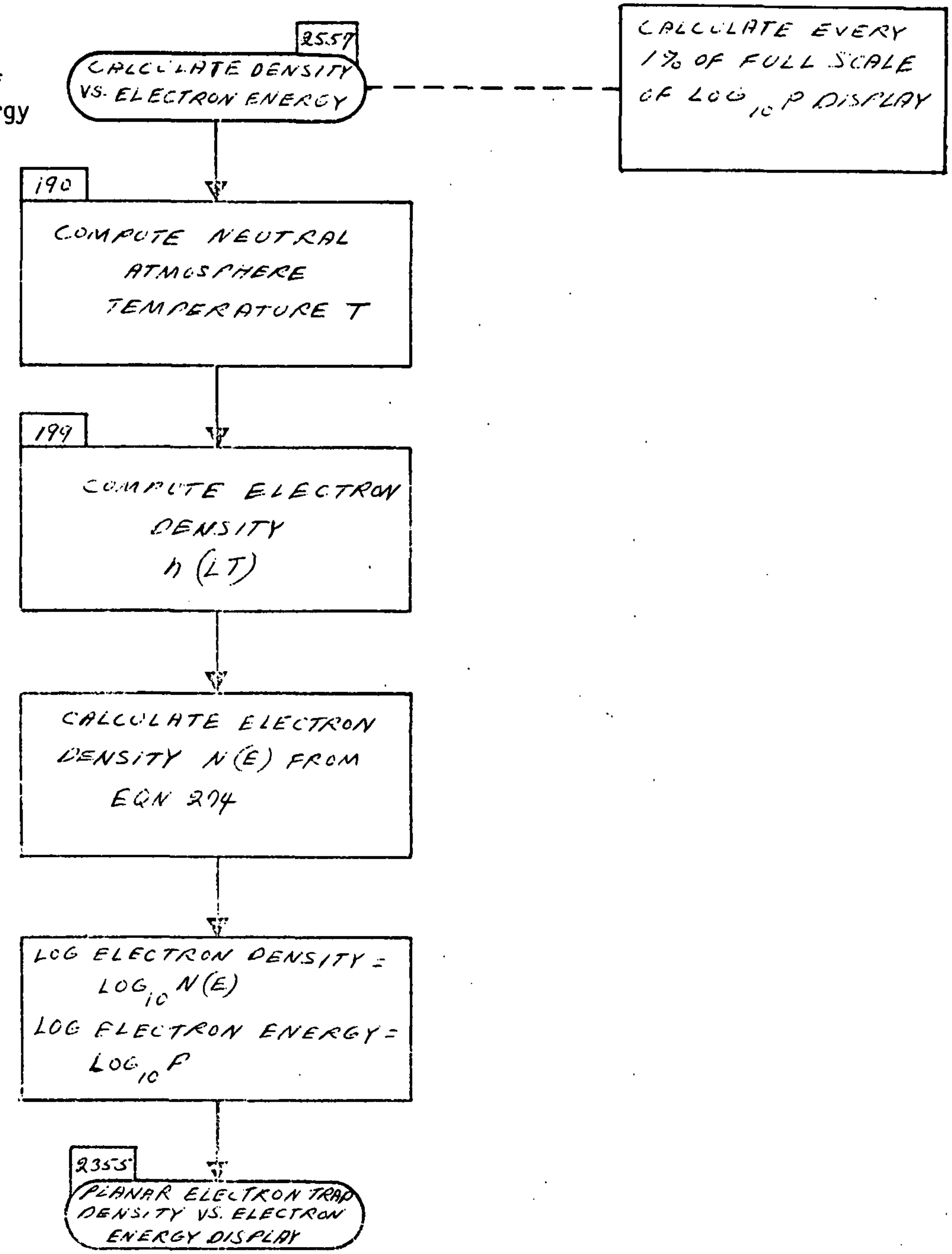
ELECTRON TEMPERATURE		KELVIN
ELECTRON VOLTS		VOLTS
ELECTRON DENSITY		PER M^3
LATITUDE		DEGREES
LOCAL TIME		HRS:MINS
ANGLE PLATFORM TO $\overline{V}$		DEGREES
ALTITUDE		KM

LOG BASE 10
OF ELECTRON
DENSITY
IN NUMBER
PER CUBIC
METER

LOG BASE 10 OF ELECTRON ENERGY IN ELECTRON VOLTS

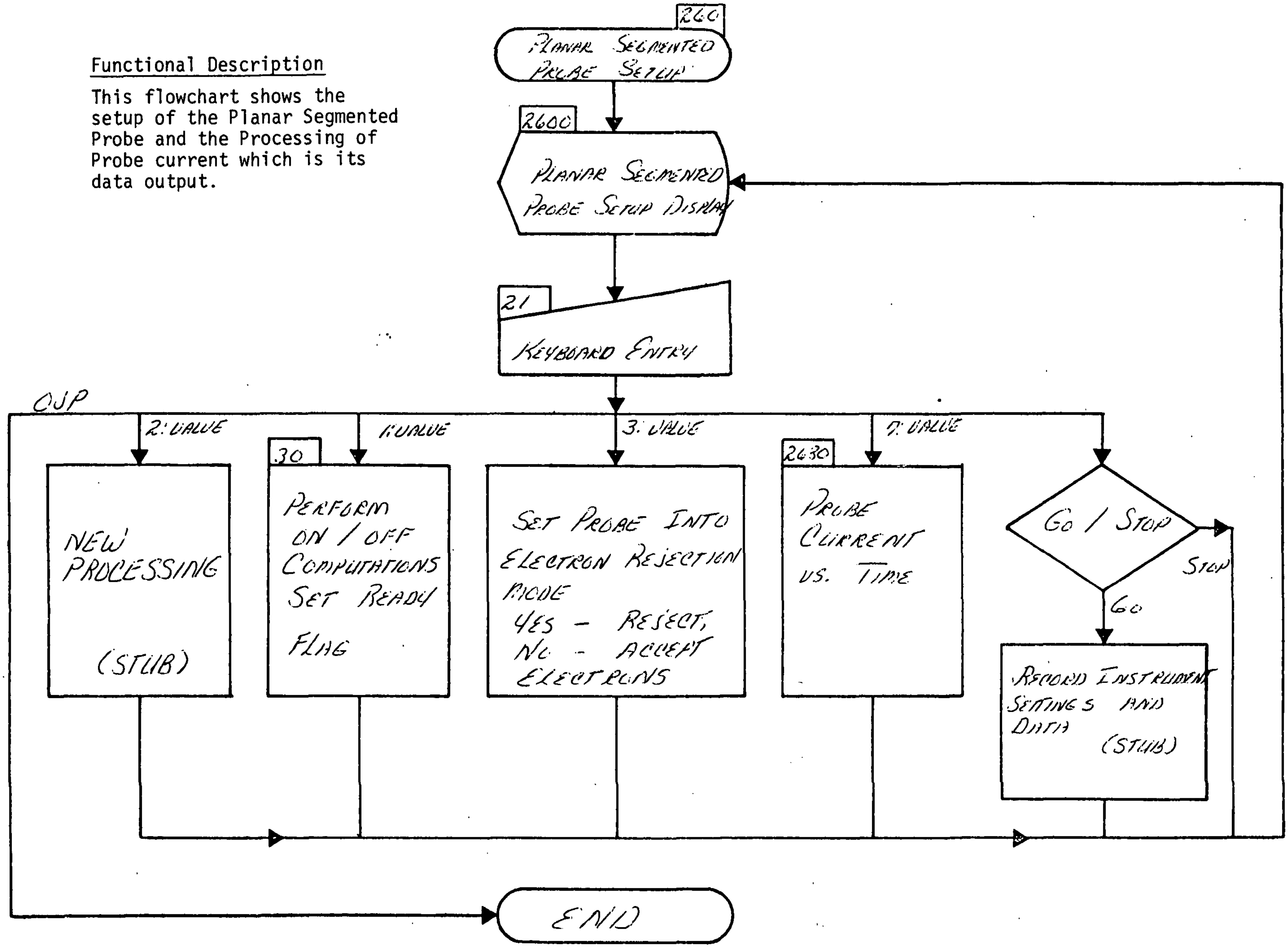
Functional Description

This flowchart shows the computation of electron density, as a function of energy based on the temperature computed from subroutine 190 and the total density of electrons computed from subroutine 199.



Functional Description

This flowchart shows the setup of the Planar Segmented Probe and the Processing of Probe current which is its data output.



2600 PLANAR SEGMENTED PROBE
SETUP DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO ____________________
____

1: ~~PLANAR SEGMENTED PROBE~~ ______ ON/OFF

[ ] READY

2: SPARE

3: PROBE INTO ELECTRON REJECTION MODE ______ YES/NO

4: SPARE

5: SPARE

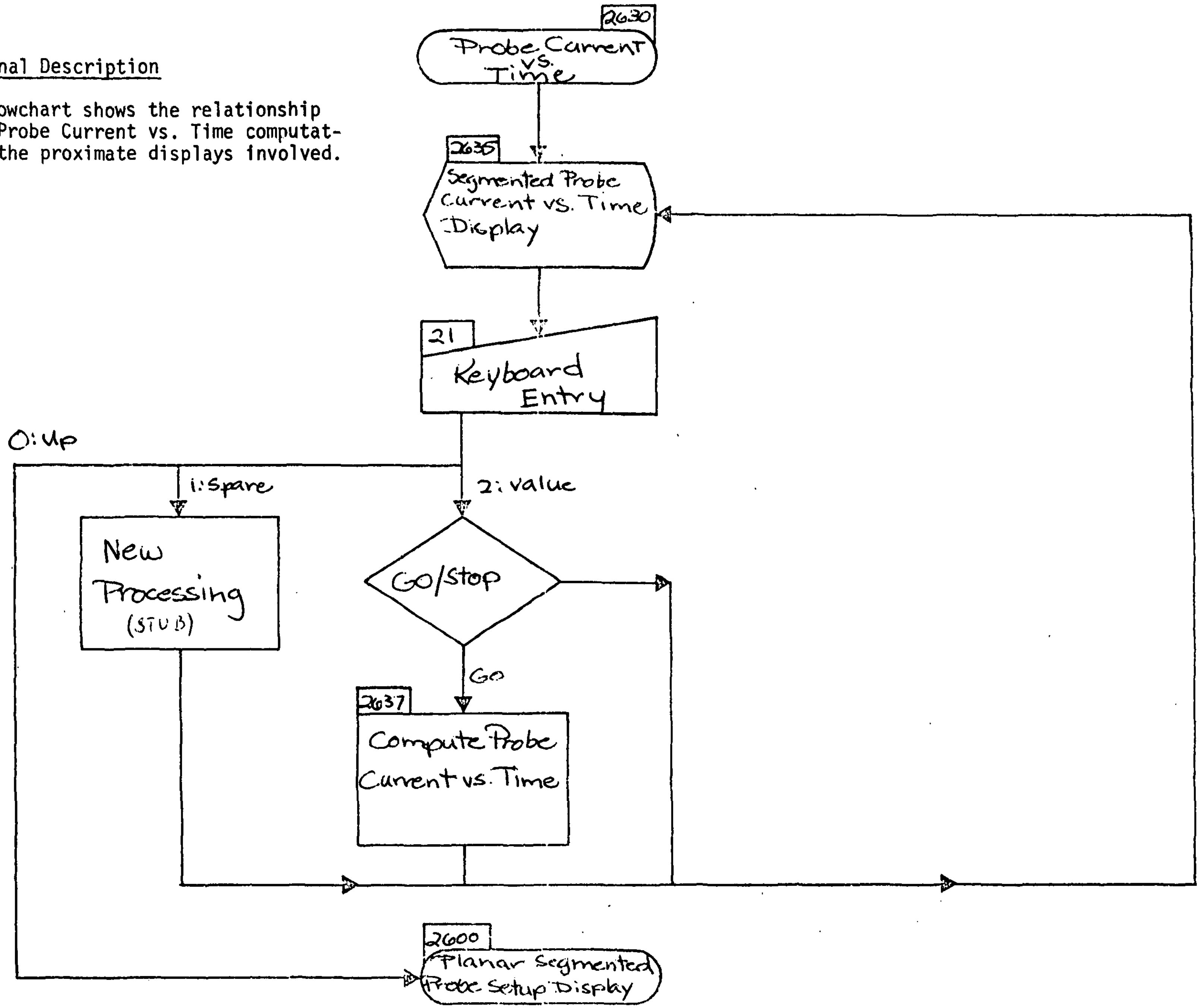
6: SPARE

7: PROBE CURRENT VS TIME ______ I/NO

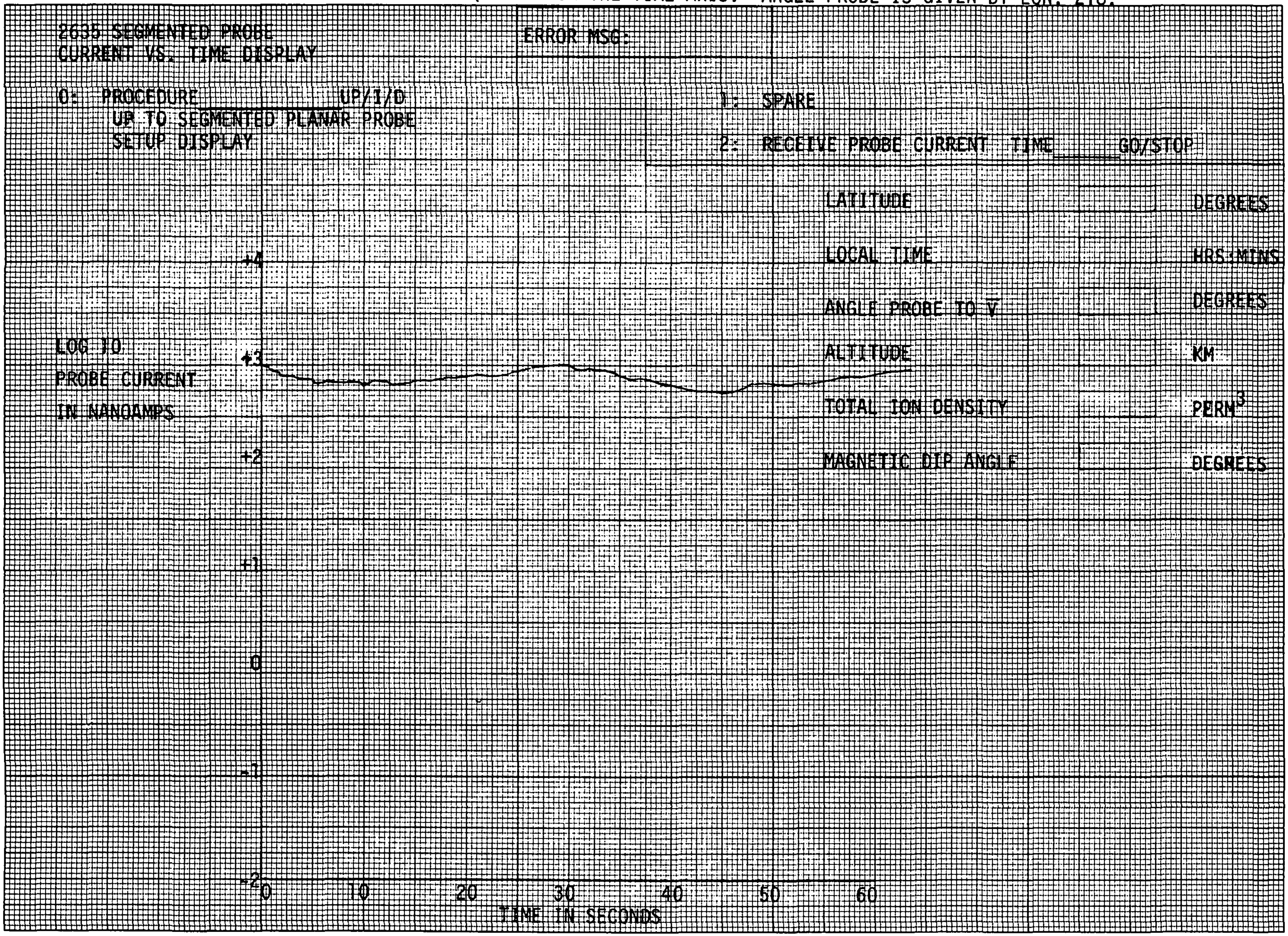
8: RECORD INSTRUMENT SETTINGS AND DATA ______ GO/STOP

Functional Description

This flowchart shows the relationship of the Probe Current vs. Time computation to the proximate displays involved.

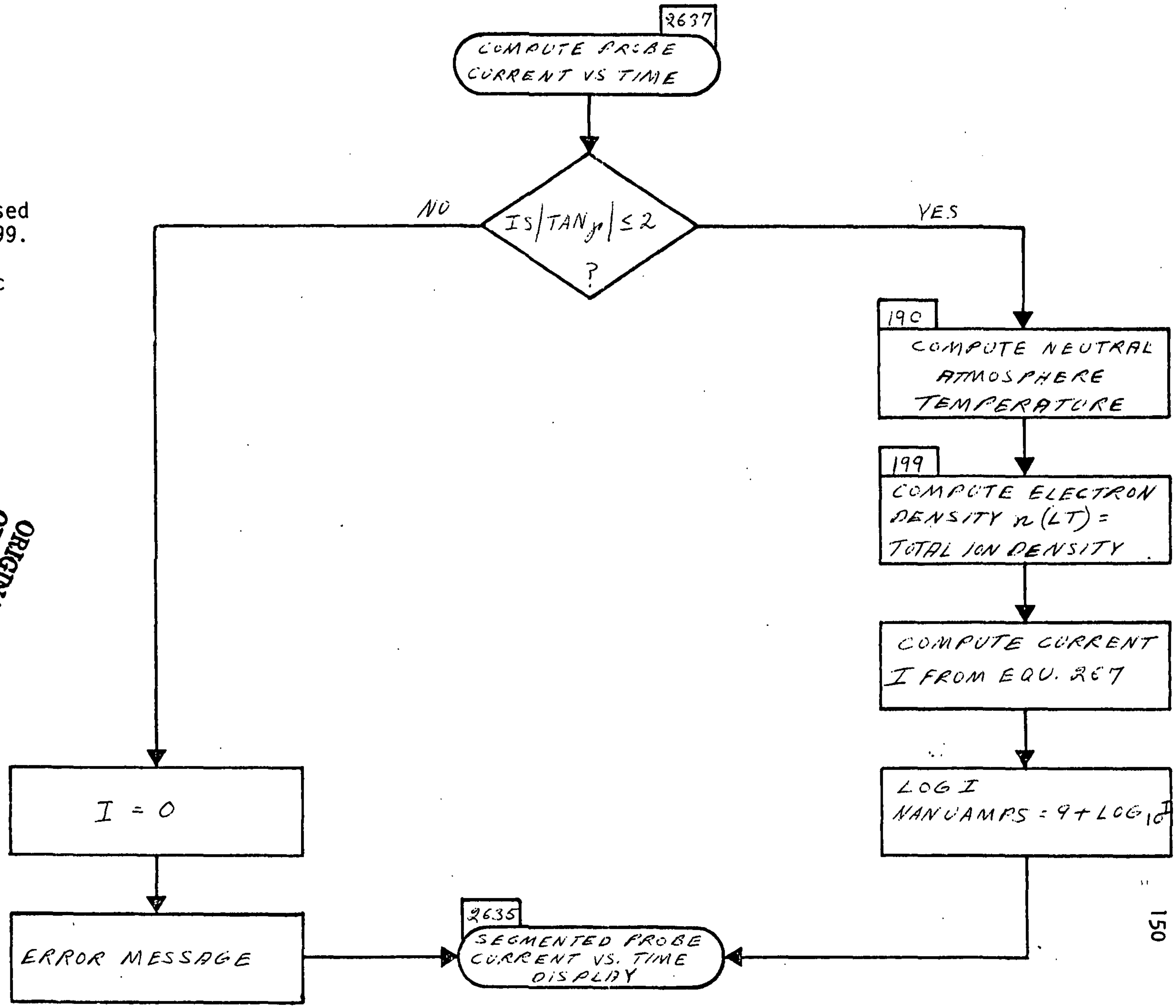


NOTE: ROLLOVER OF THIS DISPLAY IS REQUIRED FOR THE TIME AXIS. ANGLE PROBE IS GIVEN BY EQN. 218.



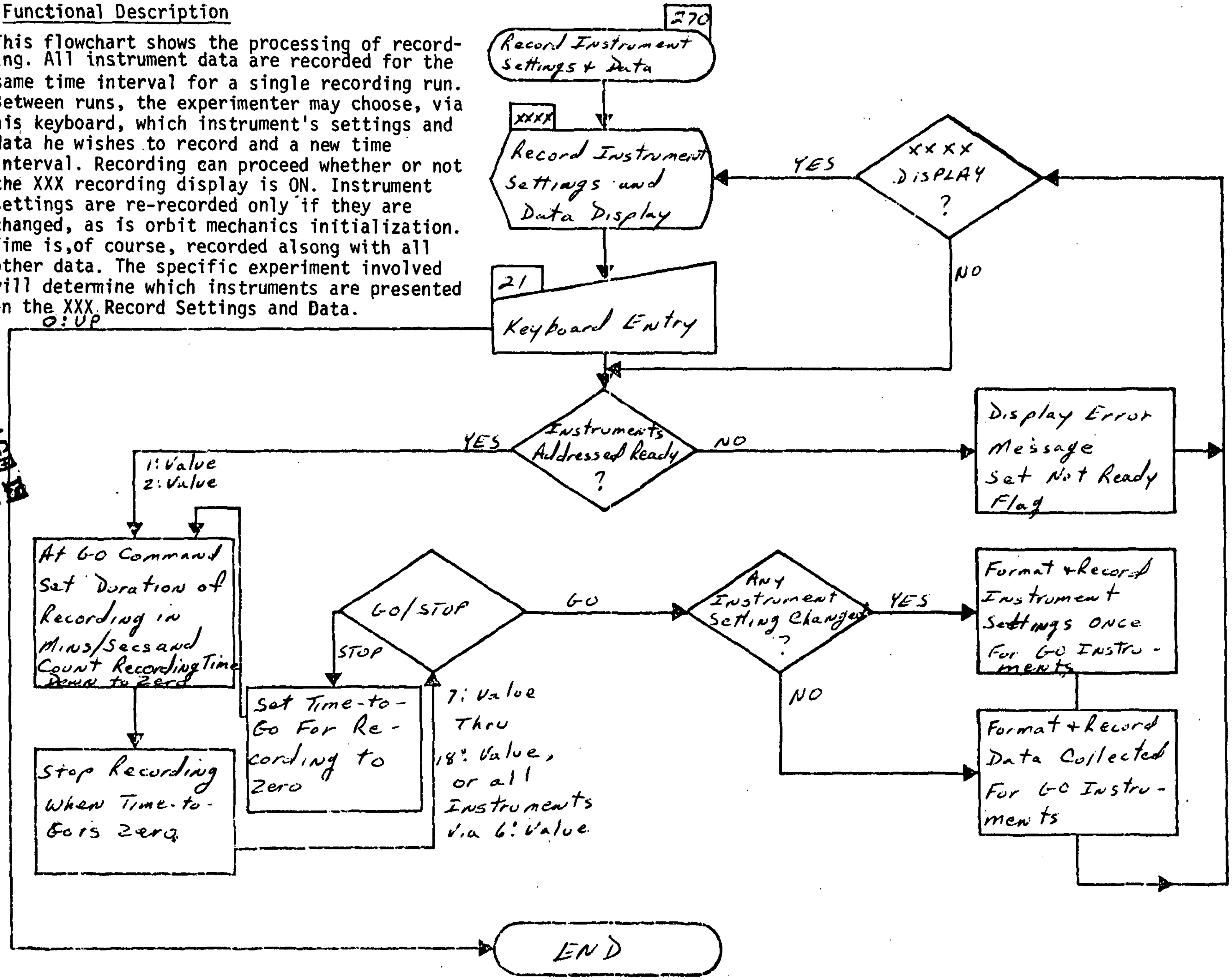
Functional Description

This flowchart shows the sequence of computations that model the segmented probe current output, based on subroutines 190 and 199. The probe will not make measurements beyond γ=arc tan2 and its use at this angle will generate an error message.



Functional Description

This flowchart shows the processing of recording. All instrument data are recorded for the same time interval for a single recording run. Between runs, the experimenter may choose, via his keyboard, which instrument's settings and data he wishes to record and a new time interval. Recording can proceed whether or not the XXX recording display is ON. Instrument settings are re-recorded only if they are changed, as is orbit mechanics initialization. Time is,of course, recorded alsong with all other data. The specific experiment involved will determine which instruments are presented on the XXX Record Settings and Data.



2710 RECORD INSTRUMENT
SETTINGS AND DATA DISPLAY

ERROR MSG:

0: PROCEDURES ______ UP/I/D

UP TO ______

1: RECORD FOR ______ XXX MINS

2: RECORD FOR ______ XX SECONDS

3: SPARE

4: SPARE

5: SPARE

6: RECORD SETTINGS AND DATA FOR ALL INSTRUMENTS ACTIVE IN THIS EXPERIMENT ______ GO/STOP
[ ] READY

7: RECORD INITIALIZATION OF ASTRONOMY/ORBIT MECHANICS (ONE-TIME) ______ GO/STOP
[ ] READY

8: RECORD CURRENT VALUES OF ASTRONOMY/ORBIT MECHANICS ______ GO/STOP
[ ] READY

9: RECORD BOOM A POSITION ______ GO/STOP
[ ] READY

10: RECORD PLATFORM POSITION ______ GO/STOP
[ ] READY

11: RECORD CYCL. EL. PROBE ______ GO/STOP
[ ] READY

12: RECORD FLUXGATE MAGNETOMETER ______ GO/STOP
[ ] READY

13: RECORD RUBIDIUM MAGNETOMETER ______ GO/STOP
[ ] READY

14: RECORD SPHERICAL ION PROBE ______ GO/STOP
[ ] READY

15: RECORD ION MASS SPECTOMETER ______ GO/STOP
[ ] READY

16: RECORD NEUTRAL MASS SPECTROMETER ______ GO/STOP
[ ] READY

17: RECORD ELECTRON TRAP ______ GO/STOP
[ ] READY

18: PLANAR SEGMENTED PROBE ______ GO/STOP
[ ] READY

RECORD TIME-TO-GO [ ] MINS:SECS

TAPE TIME-TO-GO [ ] MINS:SECS

NOTE: IF INSTRUMENTS/BOOMS/COMPUTATIONS COLLECTING THIS DATA ARE NOT READY, AN ERROR MESSAGE WILL BE SHOWN PLUS AN INDICATION IN THE READY BLOCK CONCERNED.

NOTE: DISPLAYED VALUES ARE UPDATED ONCE PER SECOND.

280 TIME AND GEOMETRIC AND
ANGLE DISPLAY SUMMARY

ERROR MSG: ____

0: PROCEDURE ____ UP/I/D
UP TO ____

1: SPARE

ORBITER ATTITUDE

Γ [ ] DEGREES

Λ [ ] DEGREES

Δ [ ] DEGREES

[ ] READY

BOOM A

Θ_A [ ] DEGREES

Φ_A [ ] DEGREES

LENGTH L_A [ ] DEGREES

[ ] READY

PLATFORM

Ω [ ] DEGREES

X [ ] DEGREES

Ψ [ ] DEGREES

[ ] READY

ANGLE PLATFORM X_P TO ORBITER $\bar{V}$ [ ] DEGREES

TIME

MET [ ] HRS:MINS:SECS

GMT [ ] HRS:MINS:SECS

LOCAL TIME LT [ ] HRS:MINS

ORBITER POSITION

EAST LONGITUDE [ ] DEGREES

SOUTH LATITUDE [ ] DEGREES

ALTITUDE [ ] KM

[ ] READY

MAGNETIC FIELD

$|\bar{B}|$ [ ] GAMMA

MAGNETIC DIP ANGLE [ ] DEGREES

[ ] READY

NOTE: IF INSTRUMENTS COLLECTING THIS DATA ARE NOT READY, AN ERROR MESSAGE WILL BE SHOWN PLUS AN INDICATION IN THE "READY" BLOCK CONCERNED.

NOTE: DISPLAYED VALUES ARE UPDATED ONCE PER SECOND.

290 PLASMA DENSITY SUMMARY DISPLAY

ERROR MSG:

0: PROCEDURE
UP TO______

______ UP/I/D

1: SPARE

NEUTRALS

O [ ] PER M^3

O2 [ ] PER M^3

N2 [ ] PER M^3

HE [ ] PER M^3

[ ] READY

IONS

O+ [ ] PER M^3

O2+ [ ] PER M^3

NO+ [ ] PER M^3

[ ] READY

ELECTRONS [ ] PER M^3

[ ] READY

TEMPERATURE [ ] DEGREES KELVIN

[ ] READY

6.3 IONOSPHERIC MEASUREMENTS WITH THE SUBSATELLITE EXPERIMENT

(The experiment procedure for this experiment is given in Section 3.3.2 of the Final Report.)

The present experiment is quite similar to the Passive Observations of the Ambient Plasma Experiment. As might be expected, the experiment data handling simulation of passive observations, functionally does not change appreciably whether the experiment sensors are mounted on a subsatellite or on the orbiter.

The only differences due to the subsatellite, that are built into the present simulation, are time delays to get the subsatellite ejected and into position, and power on, datalink activation and attitude control delays. Section 3.3.3 of the Final Report contains equations for rotating the subsatellite at a rate ω_{sp} that is different from the orbit rate ω. However, this experiment is designed to operate at $\omega_{sp} = \omega$, and Equation 314 is actually used in the form 314.5.

The transformation matrices $T_{A \to p}$ and $T_{s \to A}$ of the previous experiments are present in this subsatellite experiment, but have no effect on the computations since each is set equal to the unitary 3 x 3 matrix. Use is made of these previously derived matrices as a matter of convenience in not having to write changes to existing flowcharts.

6.3.1 Definition of Variables for Ionospheric Measurements with the Subsatellite Experiment

The following definitions define variables used in the flowcharting that follows. For a more comprehensive understanding of the equations involved see the main body of the Final Report.

E_X', E_Y', E_Z'	Components of the electric field vector E_{TOT} in the X'Y'Z' (Southward, Eastward, Upward along geocentric radius vector. Range: Plus or minus 10^4 millivolts per meter. Least count: .01 mV/meter.

6.3.2 Typical Values for Ionospheric Measurements with the Subsatellite Experiment

ω_{ps}	Satellite spin rate = Satellite orbit rate ω.
H	Satellite altitude, 300Km above spherical earth.
i	10 degrees.
LT_0	00:00:00 Hrs:Mins:Secs.
GMT_0	00:00:01 Hrs:Mins:Secs.

Satellite Attitude

Λ	80 Degrees
Γ	270 Degrees
Δ	0 Degrees

Matrix Transformations (Eqn. 218)

$T_{A \rightarrow p}$

Ω	0 Degrees
ψ	0 "
χ	0 "

$T_{s \rightarrow A}$

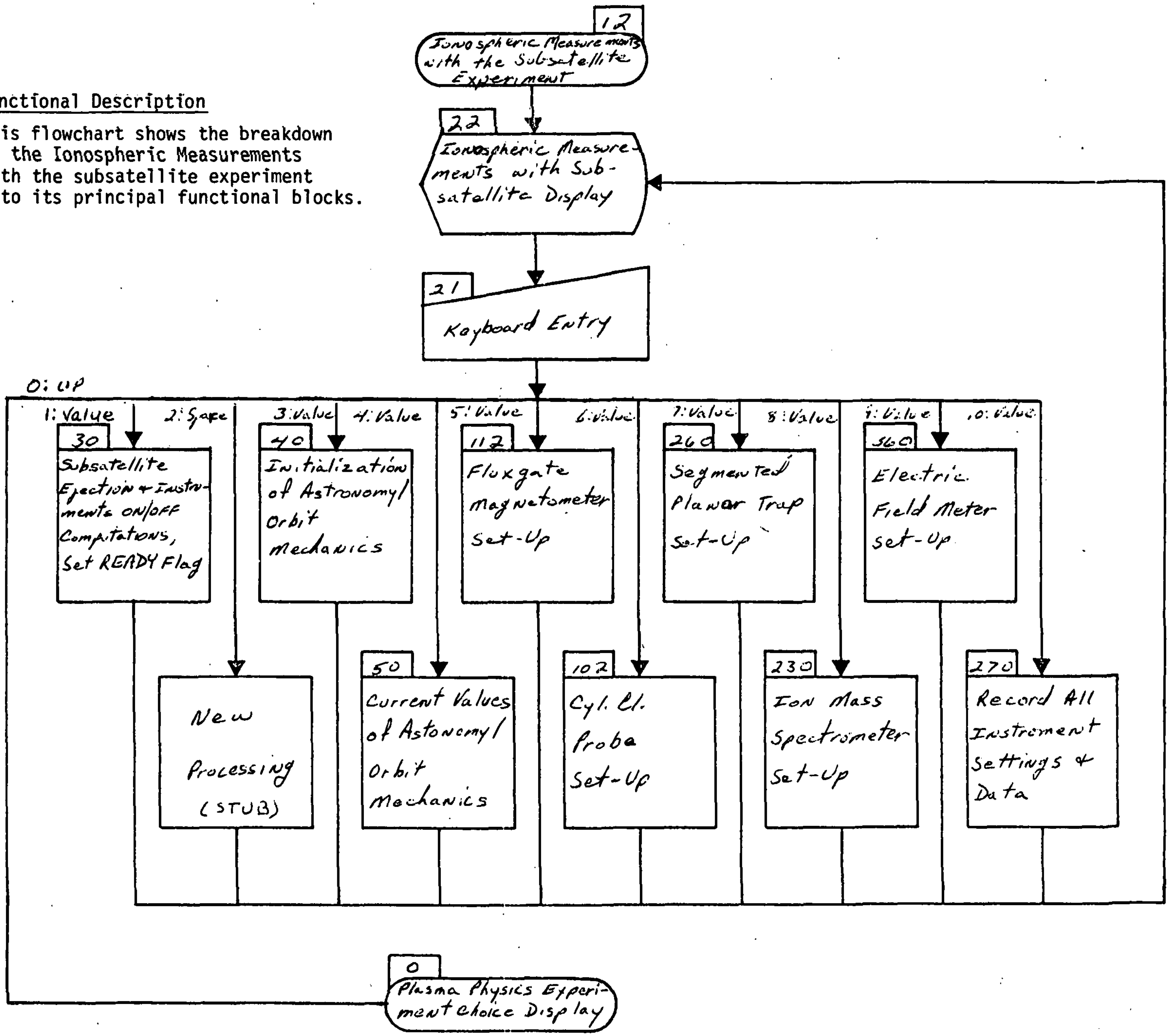
θ_A	0 "
ϕ_A	0 "

Note: Angle Platform X_1 to orbiter $\overline{V}$ = 0 degrees in this experiment. Platform X_1 is assumed identical with the subsatellite s_1 axis. This assumption permits us to use previously defined transformations

6.3.3 FLOWCHARTS AND DISPLAY FORMATS FOR IONOSPHERIC MEASUREMENTS WITH THE SUBSATELLITE EXPERIMENT

Functional Description

This flowchart shows the breakdown of the Ionospheric Measurements with the subsatellite experiment into its principal functional blocks.



ORIGINAL PAGE IS OF POOR QUALITY

22 IONOSPHERIC MEASUREMENTS
WITH THE SUBSATELLITE DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D

UP TO PLASMA PHYSICS CHOICE DISPLAY

1: SUBSATELLITE EJECTION AND INSTRUMENTS ______ ON/OFF

[ ] READY

2. SPARE

3: INITIALIZATION OF ASTRONOMY/ORBIT MECHANICS ______ I/D

4: CURRENT VALUES OF ASTRONOMY/ ORBIT MECHANICS ______ I/D

5: FLUXGATE MAGNETOMETER SETUP ______ I/D

6: CYLINDRICAL ELECTRON PROBE SETUP ______ I/D

7: SEGMENTED PLANAR TRAP SETUP ______ I/D

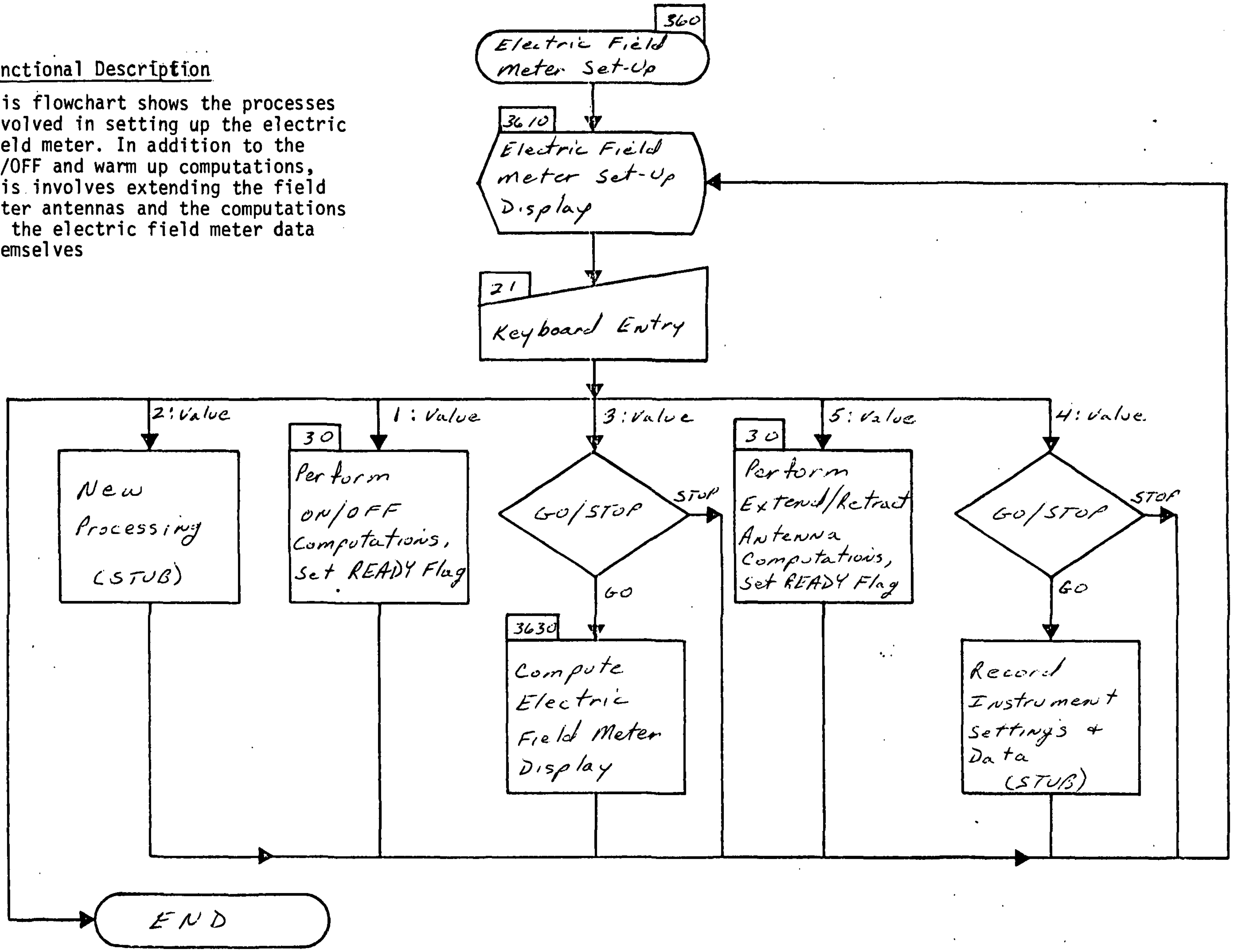
8: ION MASS SPECTROMETER SETUP ______ I/D

9: ELECTRIC FIELD METER SETUP ______ I/D

10: RECORD INSTRUMENT SETTING AND DATA ______ GO/STOP

Functional Description

This flowchart shows the processes involved in setting up the electric field meter. In addition to the ON/OFF and warm up computations, this involves extending the field meter antennas and the computations on the electric field meter data themselves



3610 ELECTRIC FIELD
METER SETUP DISPLAY

ERROR MSG:

0: PROCEDURES ______ UP/I/D

UP TO ______

______

1: ELECTRIC FIELD METER ______ ON/OFF

[ ] READY

2: SPARE

3: ELECTRIC FIELD METER DATA ______ GO/STOP

4: RECORD INSTRUMENT SETUP AND DATA ______ GO/STOP

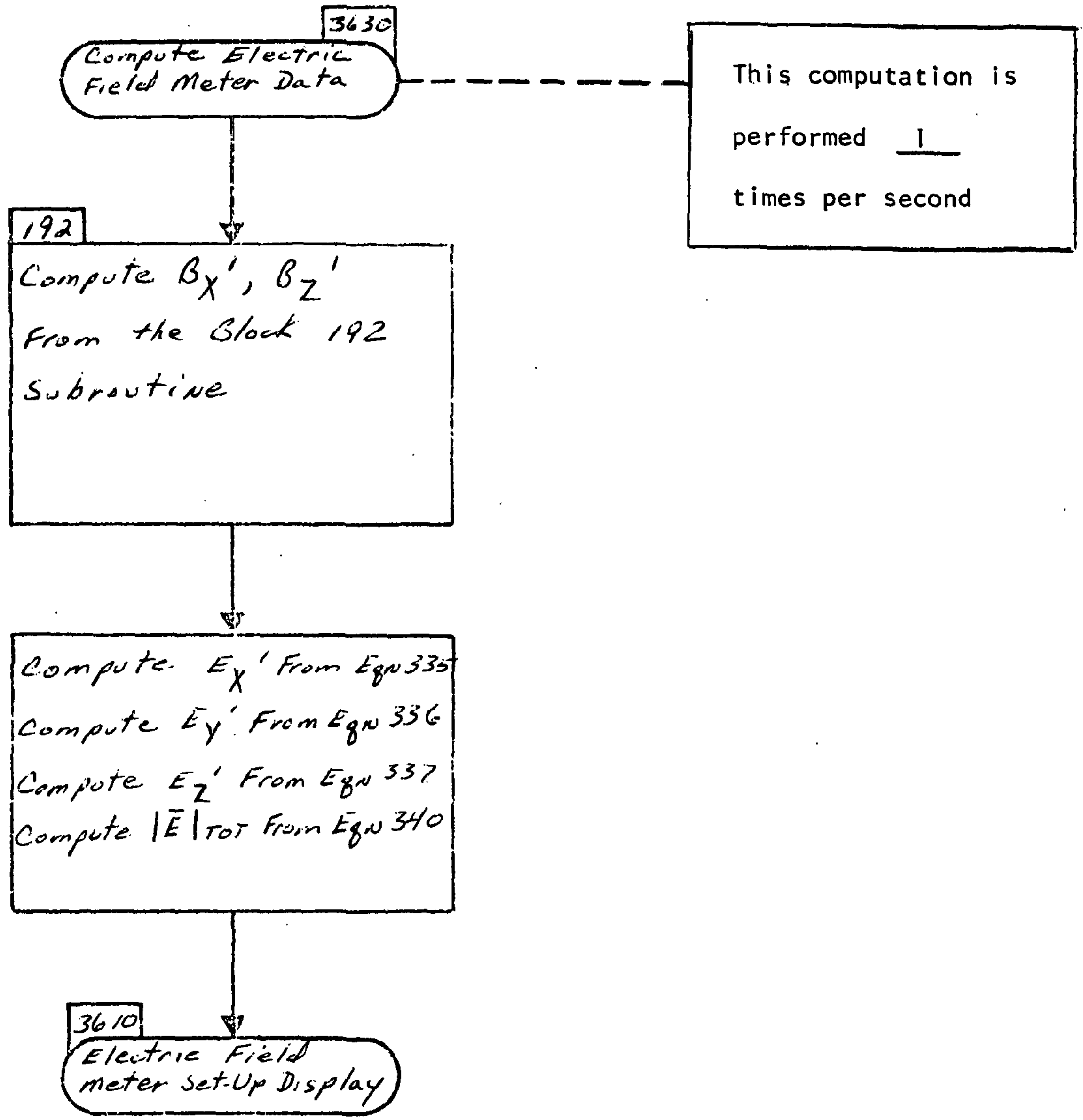
5: EXTEND/RETRACT ANTENNA ______ EXT/RET

ANTENNA [ ] READY

LATITUDE LAT	[ ]	DEGREES
LOCAL TIME	[ ]	HRS:MINS
ANGLE PLATFORM X, TO $\overline{V}$	[ ]	DEGREES
ALTITUDE	[ ]	KM
MAGNETIC DIP ANGLE	[ ]	DEGREES
SOUTHWARD E COMP.	[ ]	MILLIVOLTS/M
EASTWARD E COMP.	[ ]	MILLIVOLTS/M
RADIAL E COMP.	[ ]	MILLIVOLTS/M
TOTAL E FIELD	[ ]	MILLIVOLTS/M

Functional Description

The Electric Field is assumed generated by the motion of the Orbiter/Spacelab through the Earth's magnetic field. This flowchart shows the computation of the magnetic field components B_X', B_Z' along the local X', Y', Z' axes. It uses these for the computation of the X', Y', Z' axis components measured by the electric field meter, which are assumed to be aligned with the satellite axes.



6.4 ELECTRON ACCELERATOR BEAM MEASUREMENTS EXPERIMENT

(The experiment procedure for this experiment is given in Section 3.4.2 of the Final Report.)

The key display in this experiment is Display No. 23 showing the two elements over which the experimenter has direct control: the accelerator setup, and the setup of the Faraday cup which measures the electron beam plasma interaction. As before, the orbit parameters, initially chosen for the experiment are automatically updated once the experiment simulation has begun. In this experiment, although the accelerator setup and Faraday cup setup are done on a building block basis, the actual firing of the accelerator and the associated Faraday cup data collection is done on a combined instrument basis.

In Display 4125, the experiment having been set up, the experimenter can now perform this experiment, while using just this display. Here he can repeatedly fire the accelerator, manipulate the controls that most frequently need adjustment between firings and observe the results. Should the experimenter wish to adjust one of the less frequently adjusted parameters, e.g., photoelectron suppress voltage, then he must back up to the appropriate setup display.

6.4.1 Definition of Variables for Electron Accelerator Beam Measurements Experiment

The following definitions define variables used in the flowcharting that follows. For a more comprehensive understanding of the equations involved see the main body of the Final Report.

V_a	Diverging lens voltage in volts. Range 0 to 1000 volts. Least count 1 volt.
V_c	Converging lens voltage in volts. Range 0 to 1000 volts. Least count 1 volt.
BPHI = ϕ_0	Beam azimuth of accelerator electron beam, when leaving the accelerator at beginning of firing, relative to orbiter - fixed XYZ coordinates BPHI is measured positive from orbiter +X to the +Y direction in the XY plane. $0 \leq BPHI < 360^0$. Least count 0.1 degrees.

BOMEGA = Ω_0 — Beam deflection of accelerator electron beam, when leaving the accelerator at beginning of firing, relative to orbiter - fixed XYZ coordinates. BOMEGA is measured positive from orbiter +Z in the BPHI azimuthal plane. $0 \leq \text{BOMEGA} < 60^0$. Least count 0.1 degrees.

ϕ_1 — Beam azimuth of accelerator electron beam when leaving the accelerator relative to local magnetic field coordinates, X_1 Y_1 Z_1, with Z_1 axis along B vector, X_1 axis in orbiter XY plane and Y_1 axis to form a right-handed Cartesian coordinate system. ϕ_1 is measured positive from X_1 to Y_1 in the X_1 Y_1 plane. $0 \leq \phi < 360^0$. Least count 0.1 degrees.

Ω_1 — Beam deflection of accelerator electron beam when leaving the accelerator, relative to local magnetic field coordinates X_1 Y_1 Z_1 with Z_1 axis along B vector, X_1 axis in orbiter XY plane and Y_1 to form a right-handed Cartesian system. Ω_1 is measured positive from the Z_1 axis in the ϕ_1 plane $0 \leq \Omega_1 \leq 180^0$. Least count 0.1 degrees.

$E(\tau_b)$ — The energy remaining in the storage bank after a time τ_b seconds of beam firing, in Joules. Range 0 to 100,000 Joules. Least count 1 Joule.

E_0 — The maximum energy in the storage bank, Joules. Range 5,000 to 500,000 Joules. Least count 1 Joule.

$E(t_b)$ — The energy stored in the storage bank after t_b seconds of charging the bank. Range 5,000 to 500,000 Joules. Least count 1 Joule.

t_b — A time variable used to calculate D(t), the approximate time-to-go until full charge is reached. Range, 0 to 1000 seconds, Least count 1 second.

W_1 — The rate of scan of the accelerator beam in the BPHI radians per second. Range 0 to 200Π. Least count .01 rad/sec.

W_2	The frequency of the scan of the accelerator beam in the BOMEGA direction, radians per second. Range 0 to 2000π. Least count .01 seconds.
τ_b	Duration planned for beam firing, seconds. Range 0 to 1000. Least count .01 seconds.
$D(t)$	Approximate time-to-go to reach full charge in the energy storage bank in seconds. Range 0 to 1000 seconds. Least count 1 second.
I_h	Cathode Heater Current, amps. Range 0 to 10 amps. Least count 0.1 amps.
I_b	Accelerator beam current, amps. Range 0 to 100 amps. Least count .1 amps.
V_g	Control grid voltage, volts. Range 0 to -100 volts. Least count 0.1 volts.
I_g	Control grid current, milliamps. Range 0 to $\pm$ 100 milliamps. Least count 0.1 milliamps.
I_{cup}	Fariday cup current, amps. Range 0 to 100 milliamps. Least count 0.1 milliamps.
t_A	Time variable used to compute accelerator beam azimuth and deflection, seconds. Range 0 to τ_b. Least count .01 seconds.
P	Accelerator potential in volts.
T_f	Time-to-go until beam is fired, in seconds. Range 0 to 240 seconds. Least count 1 second.
τ_d	Time period required to drain energy storage bank, seconds. Range 0 to 1000 seconds. Least count 0.01 seconds.

6.4.2 Typical Values for Electron Accelerator Beam Measurements Experiment

The following values of parameters are considered typical, and may, for example, be used as default values.

V_d	=	100 Volts
V_c	=	100 Volts
BPHI	=	0 Degrees
BOMEGA	=	10 Degrees
E_0	=	100,000 Joules
D(t)	=	Counts down from about 48 seconds to zero, if storage bank initially empty.
W_1	=	2Π
W_2	=	20Π
I_h	=	4.0 Amps
V_g	=	0.0 Volts in test mode -100 Volts during pre-firing mode -5 Volts during firing
P	=	10,000 Volts

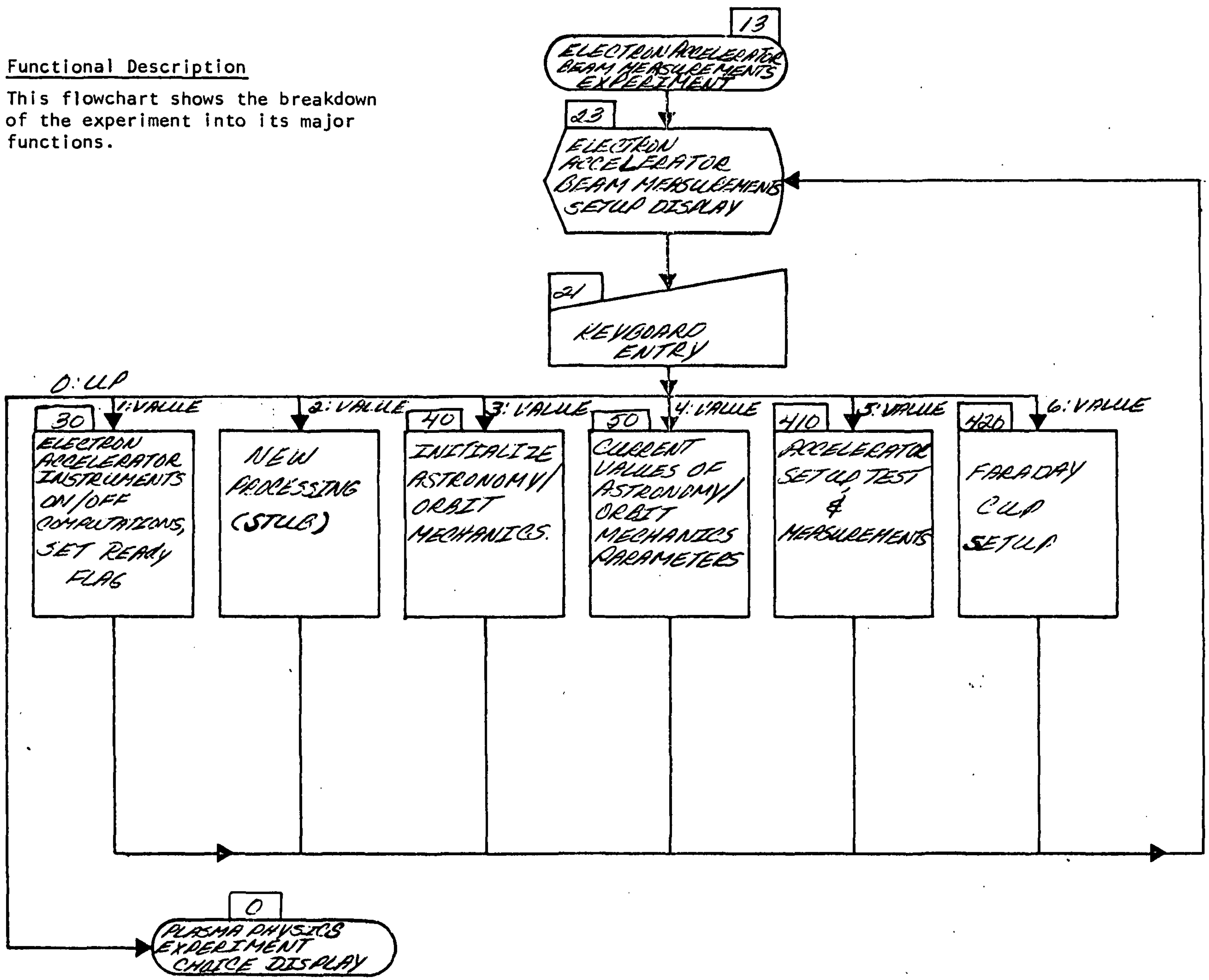
ORBITER ATTITUDE, ALTITUDE, INCLINATION

Γ	=	270 Degrees
Λ	=	90 Degrees
Δ	=	0 Degrees
H	=	400 Kilometers
i	=	0 Degrees, Equatorial Orbit

6.4.3 FLOWCHARTS AND DISPLAY FORMATS FOR ELECTRON ACCELERATOR BEAM MEASUREMENTS EXPERIMENT

Functional Description

This flowchart shows the breakdown of the experiment into its major functions.



23 ELECTRON ACCELERATOR BEAM
MEASUREMENTS EXPERIMENT DISPLAY

ERROR MSG:

0: PROCEDURE ________ UP/I/D
UP TO PLASMA PHYSICS EXPERIMENT
CHOICE DISPLAY

1: ELECTRON ACCELERATOR BEAM ________ ON/OFF
INSTRUMENTS

[ ] READY

2: SPARE

3: INITIALIZE ASTRONOMY/ORBIT ________ I/D
MECHANICS

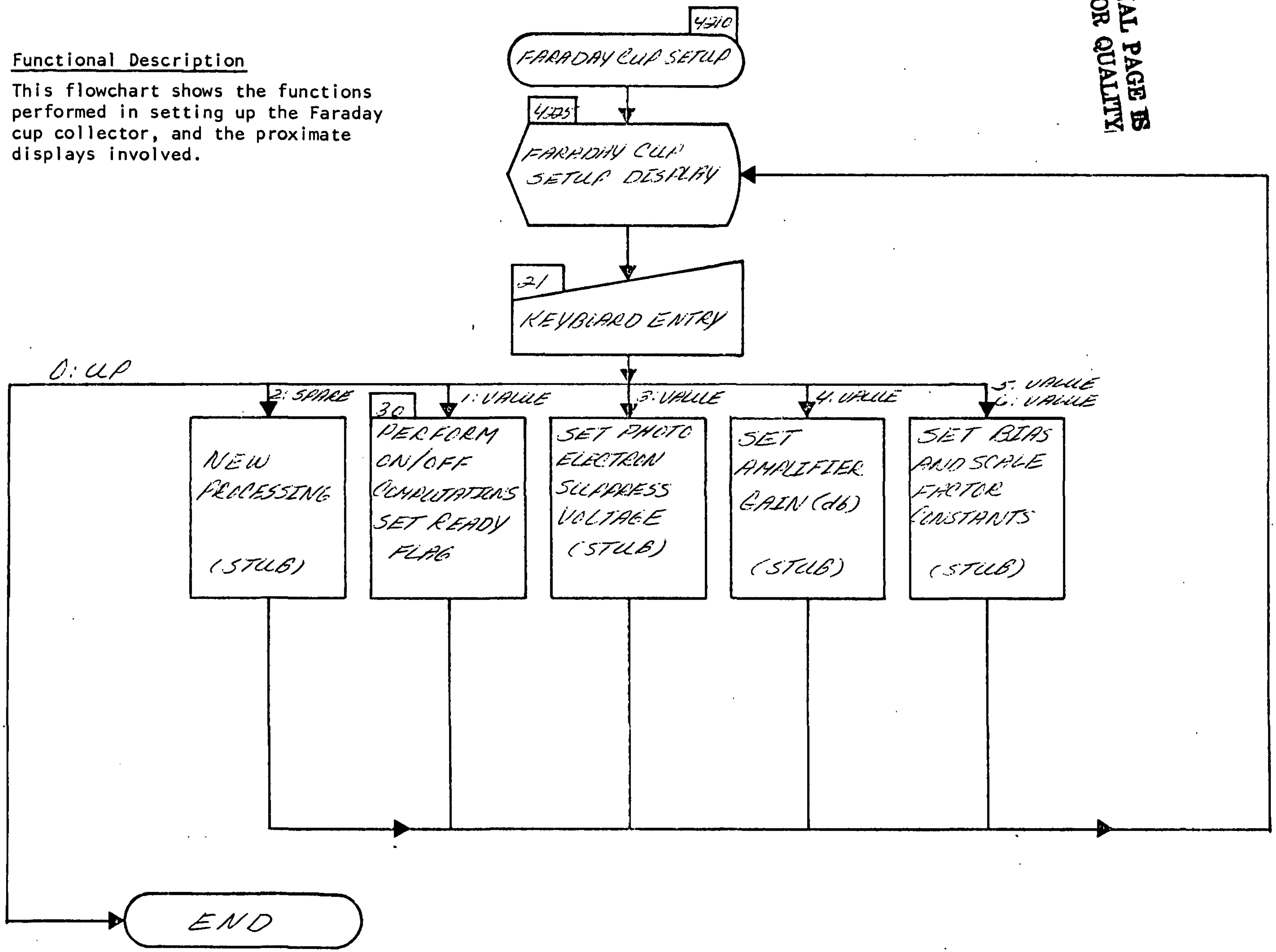
4: CURRENT VALUES OF ASTRONOMY/ORBIT ________ I/D
MECHANICS

5: ACCELERATOR SETUP ________ I/D

6: FARADAY CUP SETUP ________ I/D

Functional Description

This flowchart shows the functions performed in setting up the Faraday cup collector, and the proximate displays involved.



4225 FARADAY CUP
SETUP DISPLAY

ERROR MSG:

0: PROCEDURE ____ UP/I/D

UP TO ______________________________

____

1: FARADAY CUP ____ ON/OFF

[ ] READY

2: SPARE

3: SET PHOTO ELECTRON SUPPRESS VOLTAGE ____ XXXX VOLTS

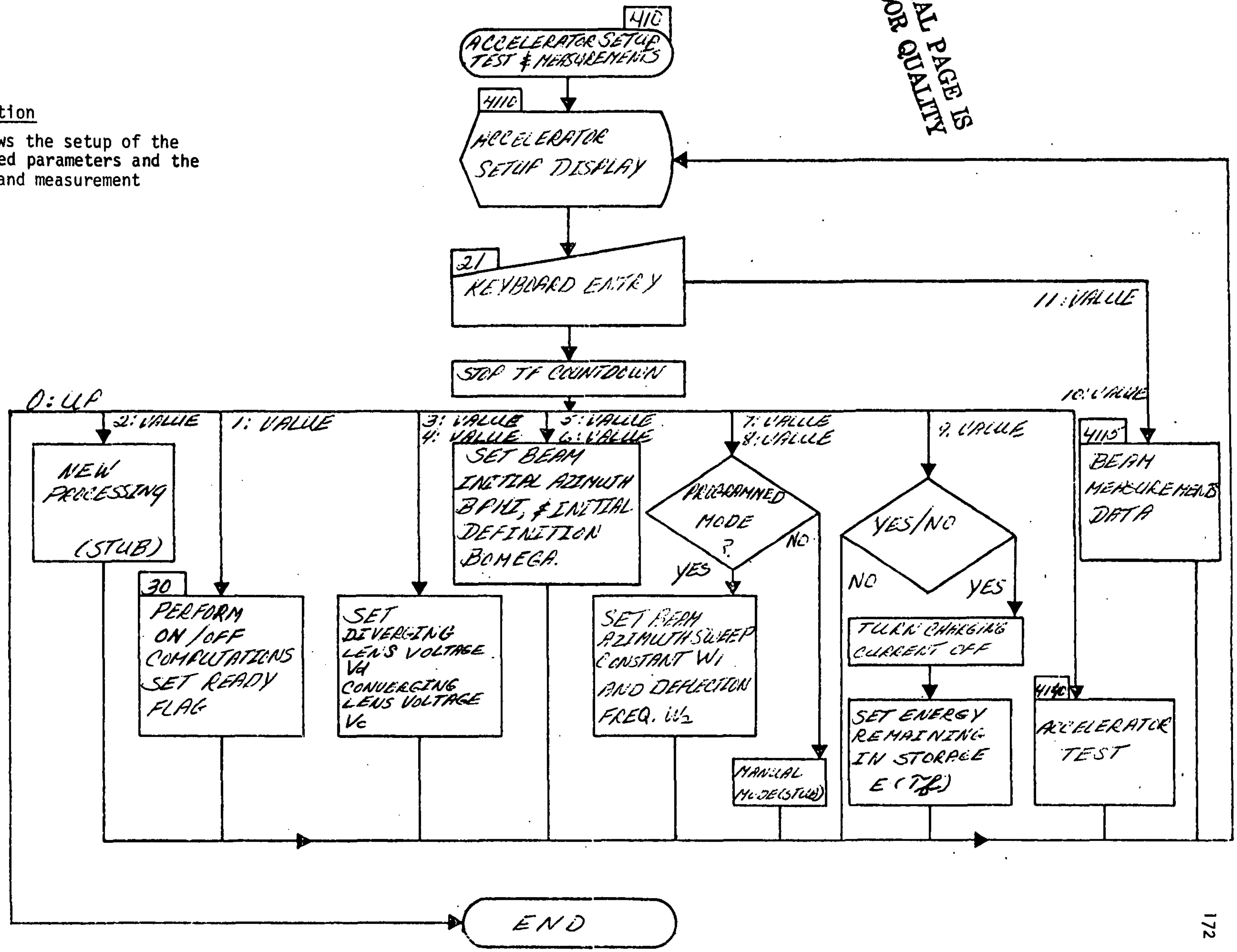
4: SET AMPLIFIER GAIN ____ XX db

5: SET BIAS CONSTANT ____ MILLIAMPS

6: SET SCALE FACTOR ____

Functional Description

This flowchart shows the setup of the infrequently changed parameters and the entry to the Test and measurement functions.



4110 ACCELERATOR SETUP DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO ______________________________
____

1: ACCELERATOR ______ ON/OFF

[ ] READY

2: SPARE

3: SET DIVERGING LENS VOLTAGE ______ XXX VOLTS

4: SET CONVERGING LENS VOLTAGE ______ XXX VOLTS

5: SET BEAM INITIAL AZIMUTH ______ XXX DEGREES

6: SET BEAM INITIAL DEFLECTION ______ XXX DEGREES

7: SET BEAM AZIMUTH SWEEP RATE ______ XXX.XX RAD/SEC

8: SET BEAM DEFLECTION FREQUENCY ______ XXXX.XX RAD/SEC

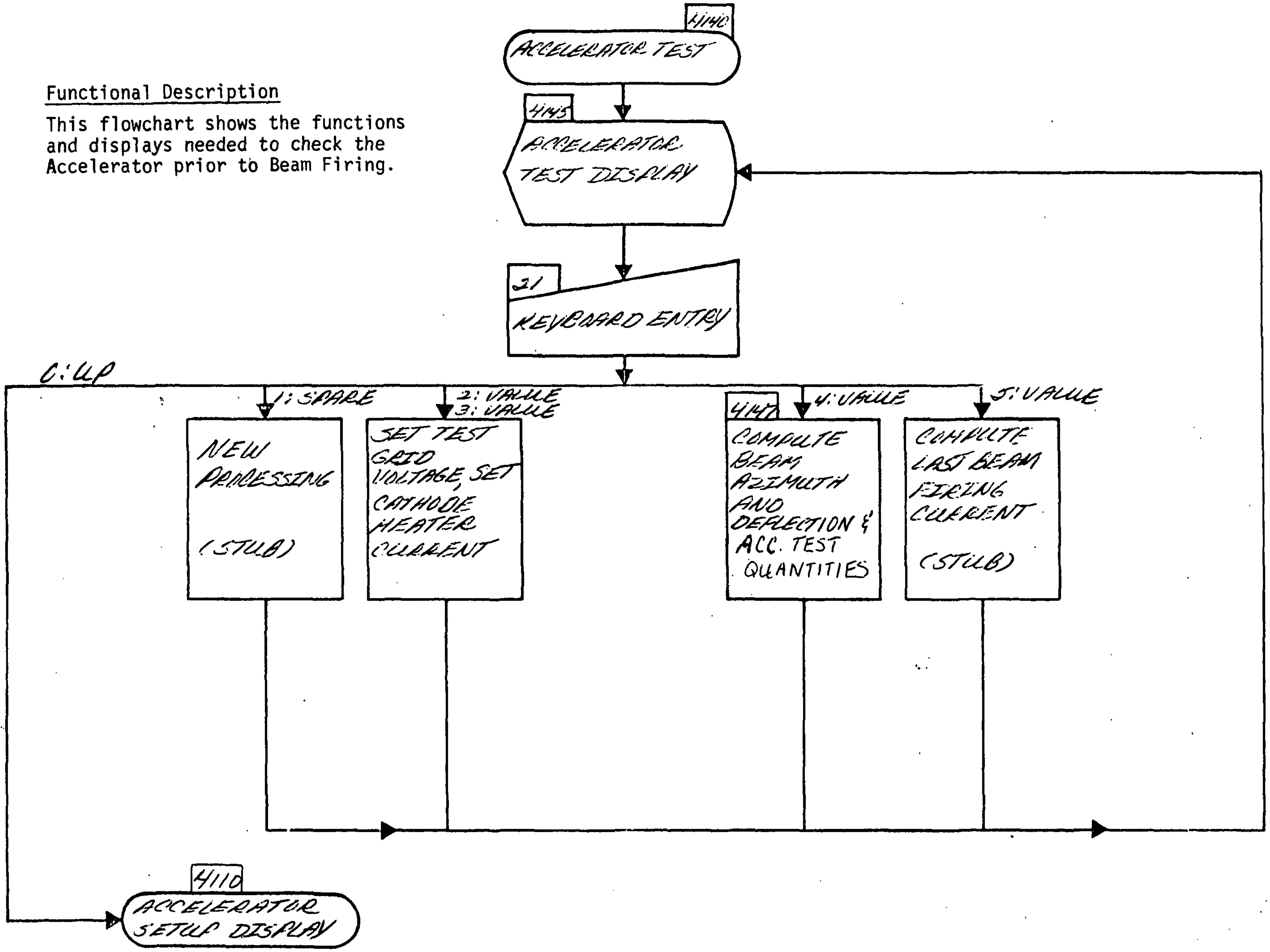
9: DRAIN STORAGE BANK TO ZERO ______ YES/NO

10: ACCELERATOR TEST ______ I/D

11: BEAM MEASUREMENTS DATA ______ I/D

Functional Description

This flowchart shows the functions and displays needed to check the Accelerator prior to Beam Firing.



4145 ACCELERATOR TEST DISPLAY

ERROR MSG:

GRID CURRENT [ ] mA.

0: PROCEDURE ______ UP/I/D

UP TO ACCELERATOR SETUP DISPLAY

TEST BEAM CURRENT [ ] AMPS

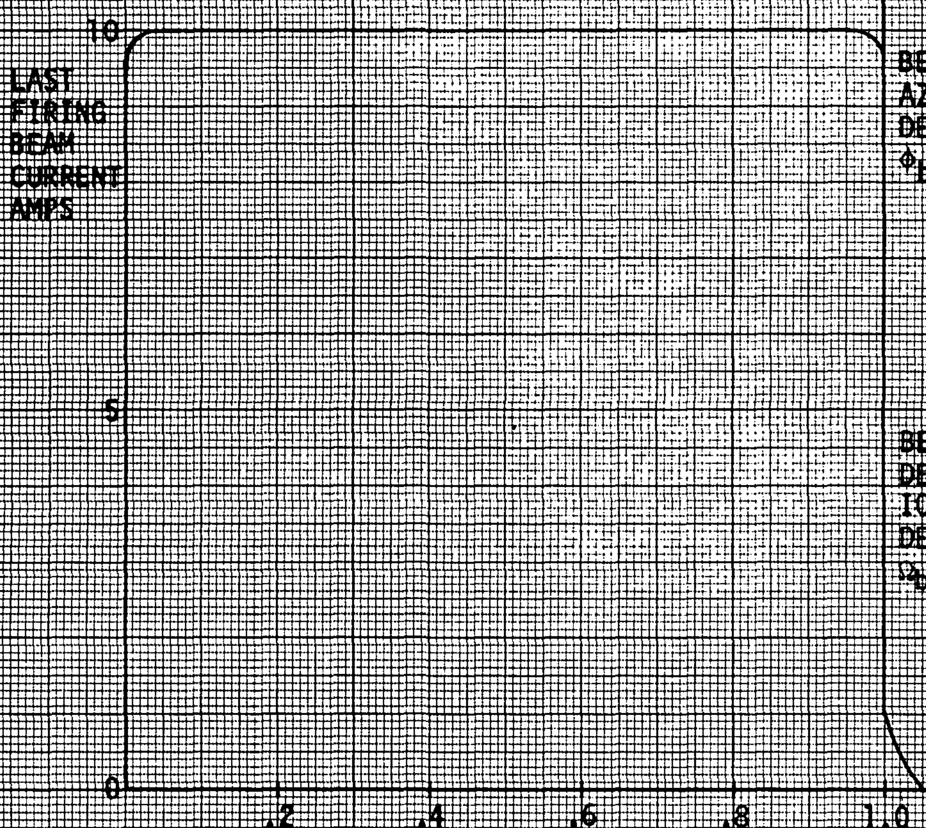
2: SET CATHODE HEATER CURRENT ______ X.X AMPS

3: SET GRID VOLTAGE ______ XX.X VOLTS

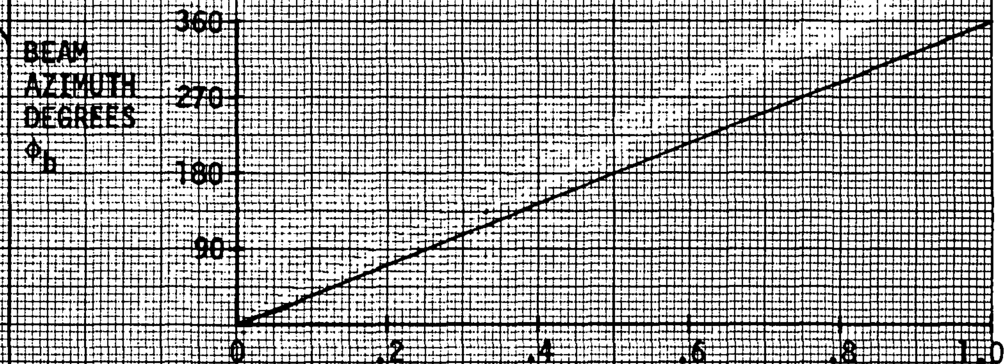
1: SPARE

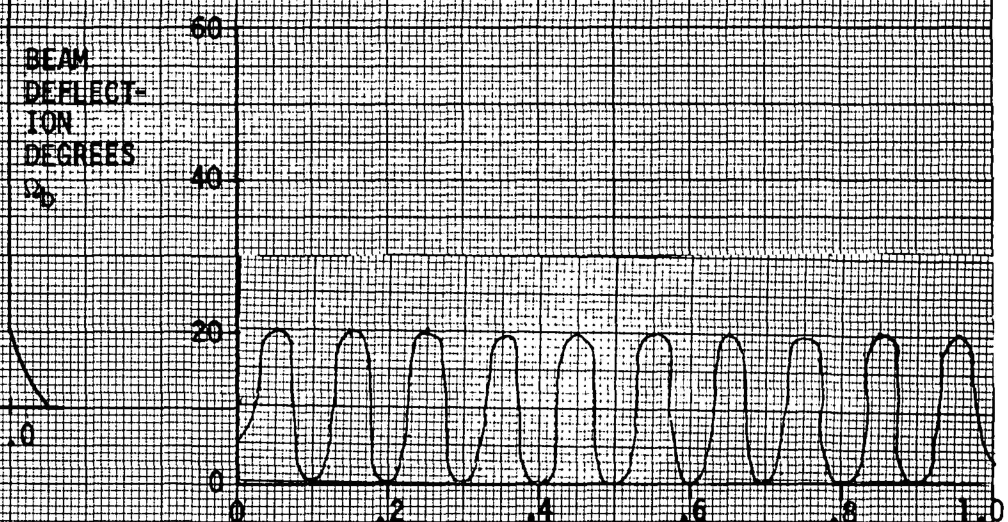
4: BEAM AZIMUTH & DEFLECTION ______ YES/NO

5: LAST FIRING BEAM CURRENT ______ YES/NO



TIME FROM FIRING START (SECONDS)





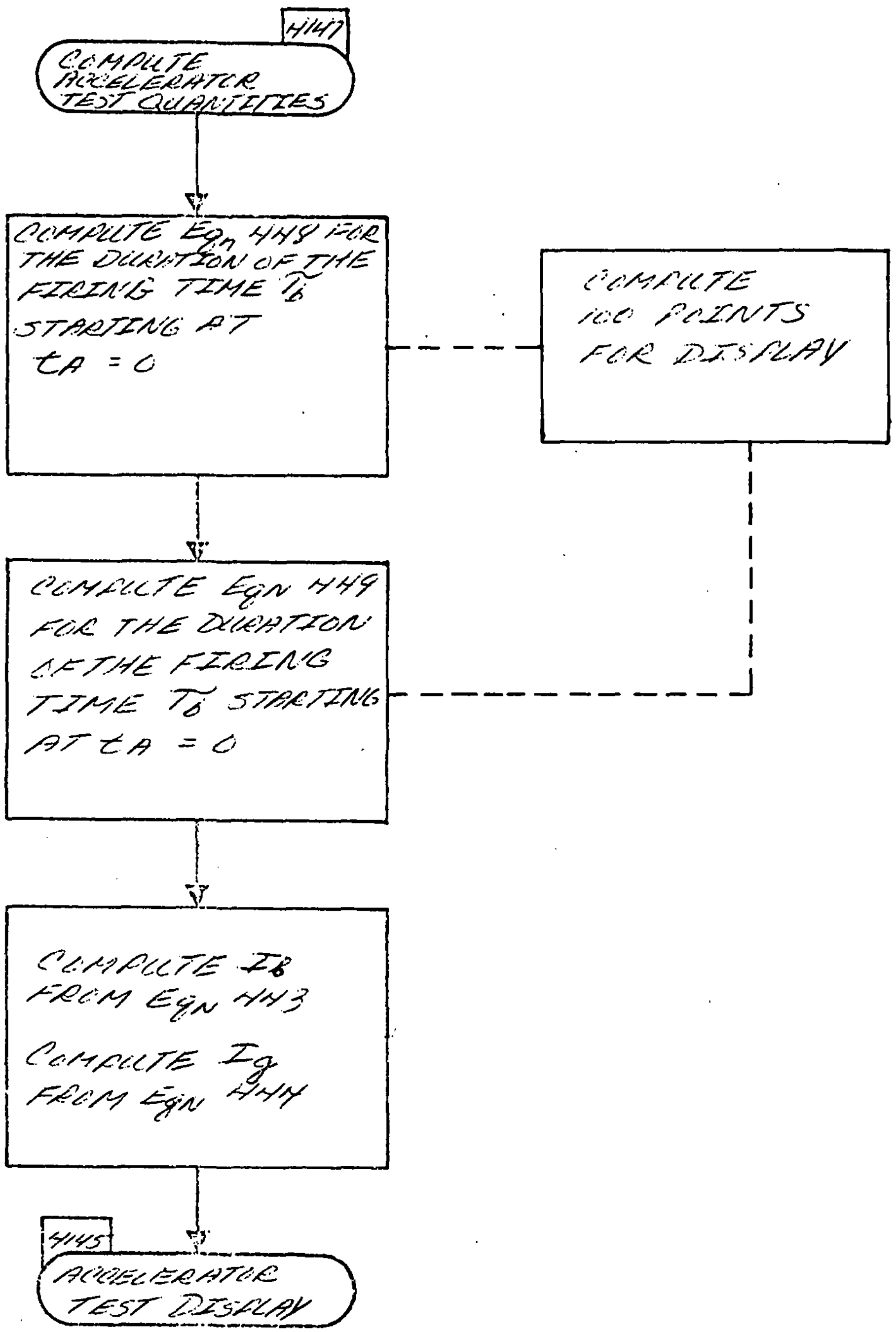
TIME FROM FIRING START (SECONDS)

Functional Description

This flowchart shows the computation of

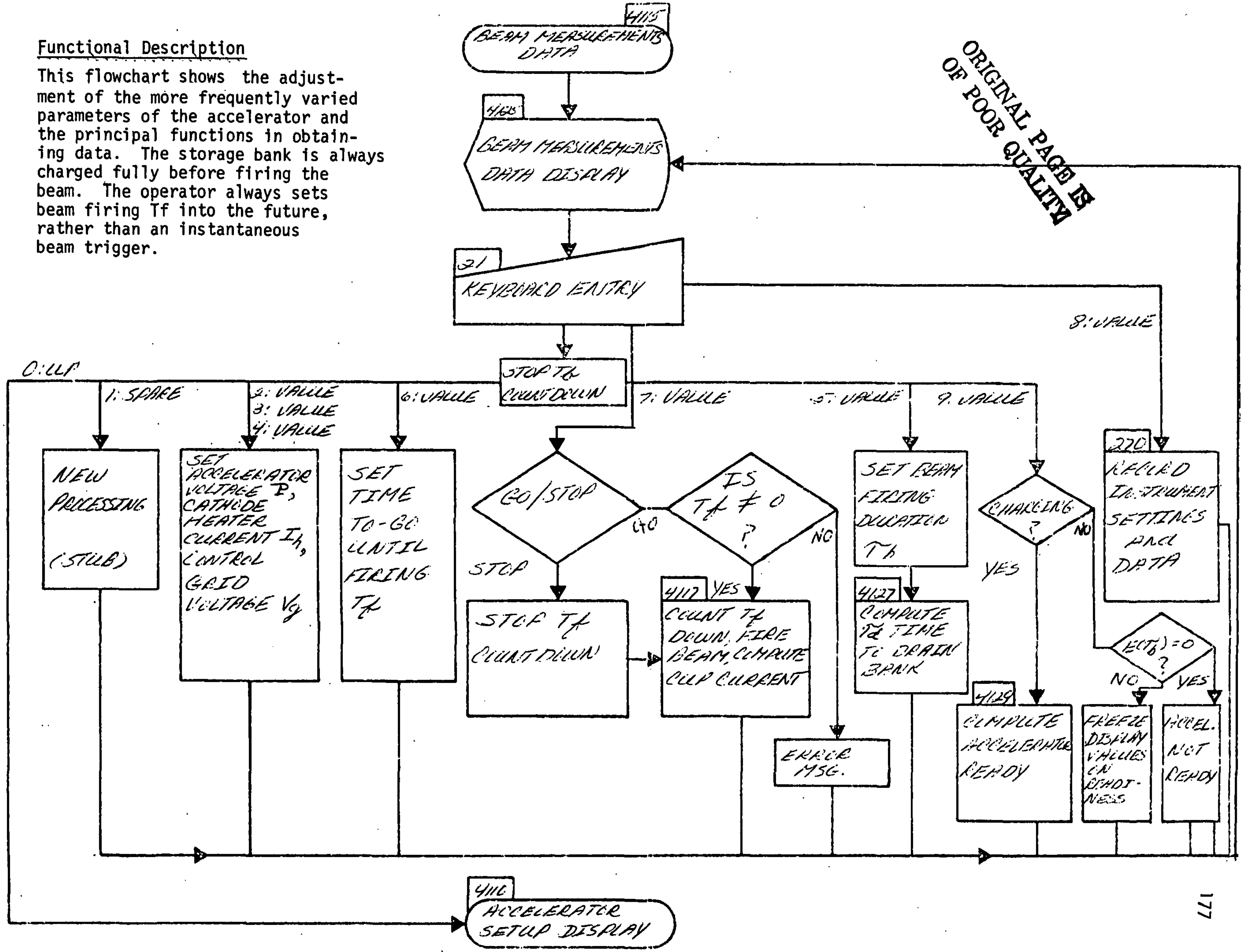
Beam azimuth $\phi 1$,
Beam Deflection $\Omega 1$,
Beam Current I, and
Grid Current Ig

that are needed for Acceleration Test Purposes.



Functional Description

This flowchart shows the adjustment of the more frequently varied parameters of the accelerator and the principal functions in obtaining data. The storage bank is always charged fully before firing the beam. The operator always sets beam firing Tf into the future, rather than an instantaneous beam trigger.



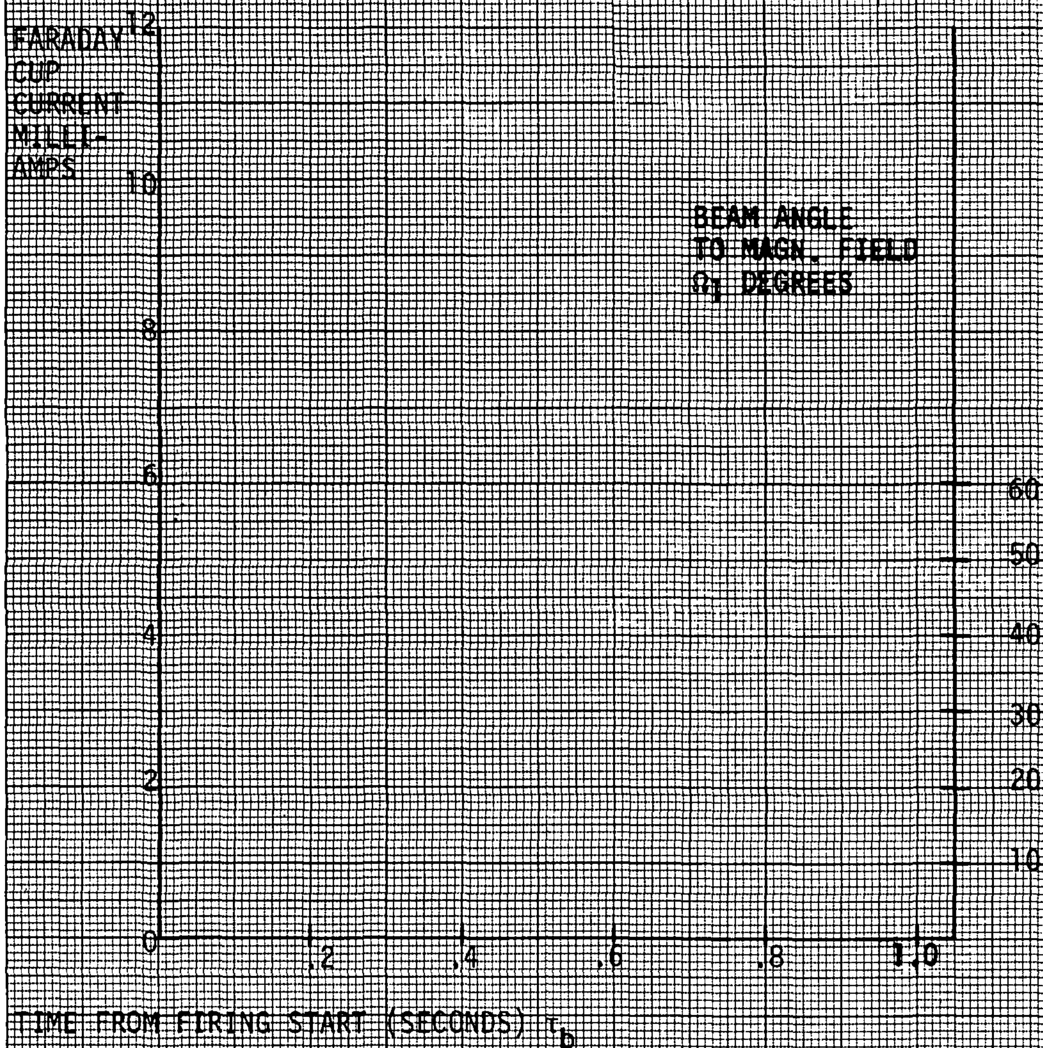
4125 BEAM MEASUREMENTS
DATA DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D

UP TO ACCELERATOR SETUP DISPLAY

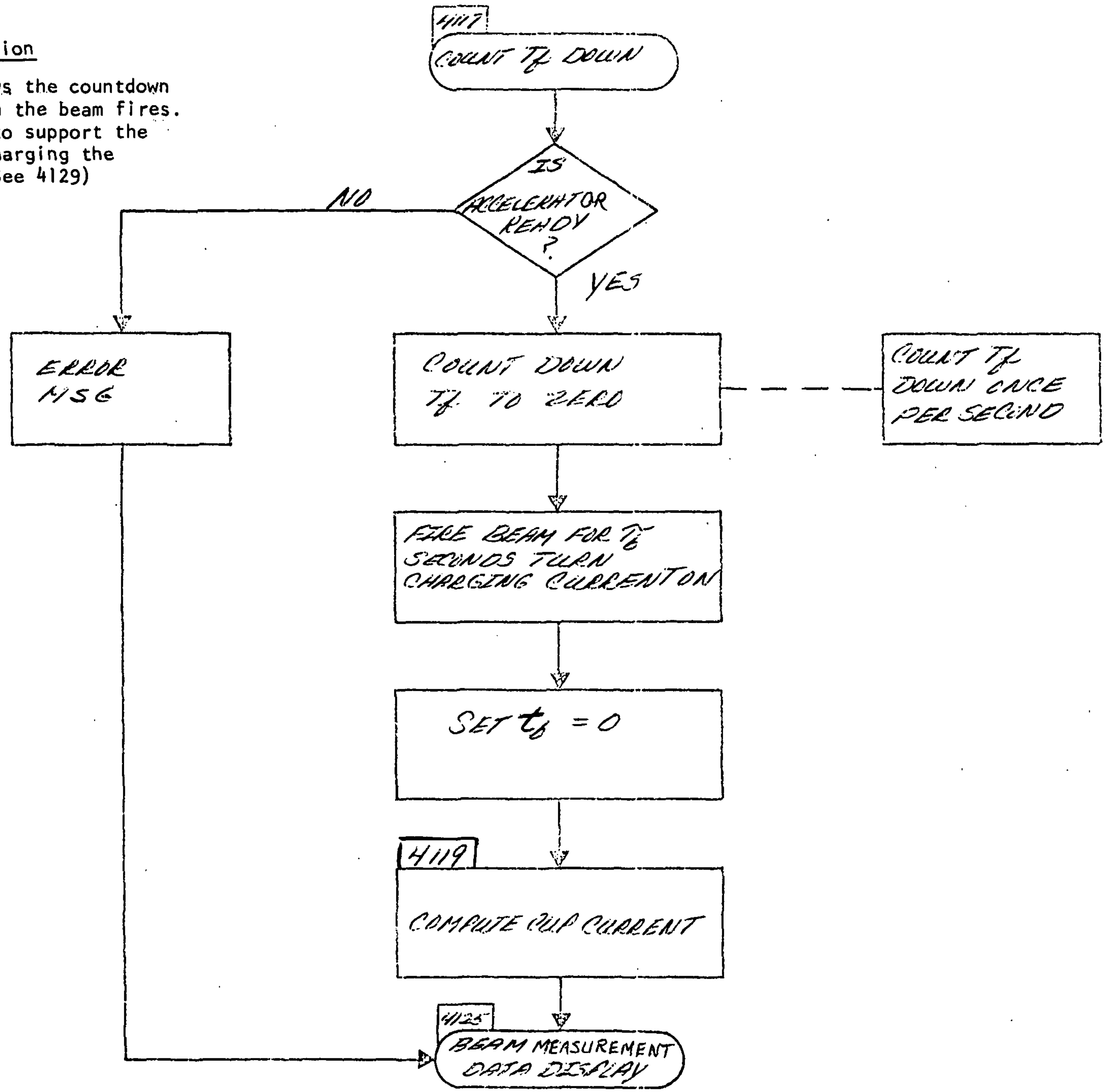
1: SPARE ______



2:	SET ACCELERATOR VOLTAGE P	______	XXXXX VOLTS
3:	SET CATHODE HEATER CURRENT	______	X.X AMPS
4:	SET CONTROL GRID VOLTAGE	______	XX.X VOLTS
5:	BEAM FIRING DURATION τ_b	______	XXX.XX SECONDS
	MAX FIRING DURATION	☐	SECONDS
6:	SET TIME TO GO UNTIL FIRING	______	XXX SECONDS
7:	FIRING COUNTDOWN	______	GO/STOP
	APPROX. TIME TO REACH FULL CHARGE	☐	SECONDS
	ACCELERATOR	☐	READY
8:	RECORD INSTRUMENT SETTINGS AND DATA	______	GO/STOP
	LATITUDE	☐	DEGREES
	LOCAL TIME	☐	HRS:MINS
	ALTITUDE	☐	KM
	MAG. DIP ANGLE	☐	DEGREES
	CHARGING CURRENT	☐	AMPS
9:	CHARGING CURRENT	______	ON/OFF

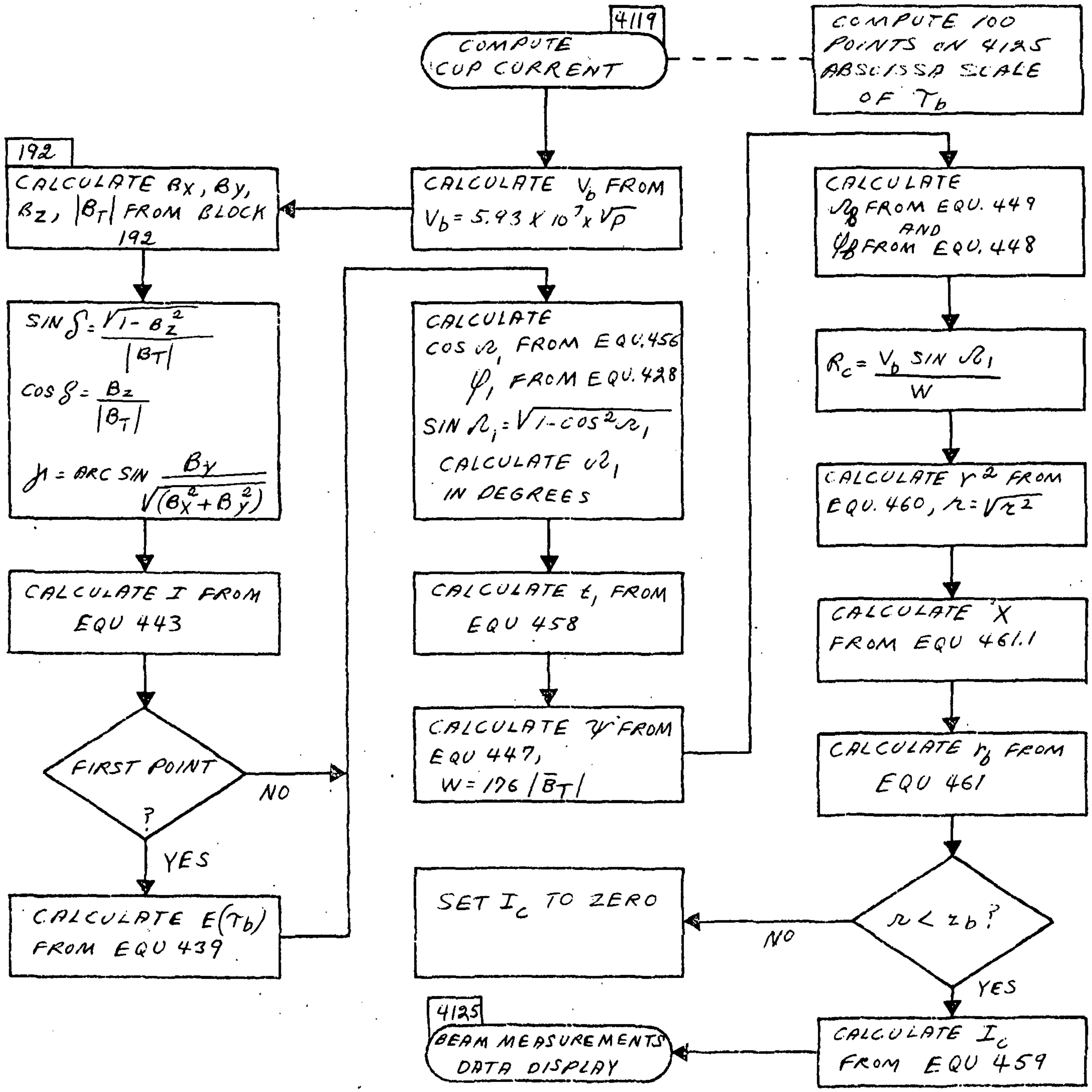
Functional Description

This flowchart shows the countdown of Tf to zero, when the beam fires. tb is set to zero to support the computation of recharging the energy storage. (See 4129)



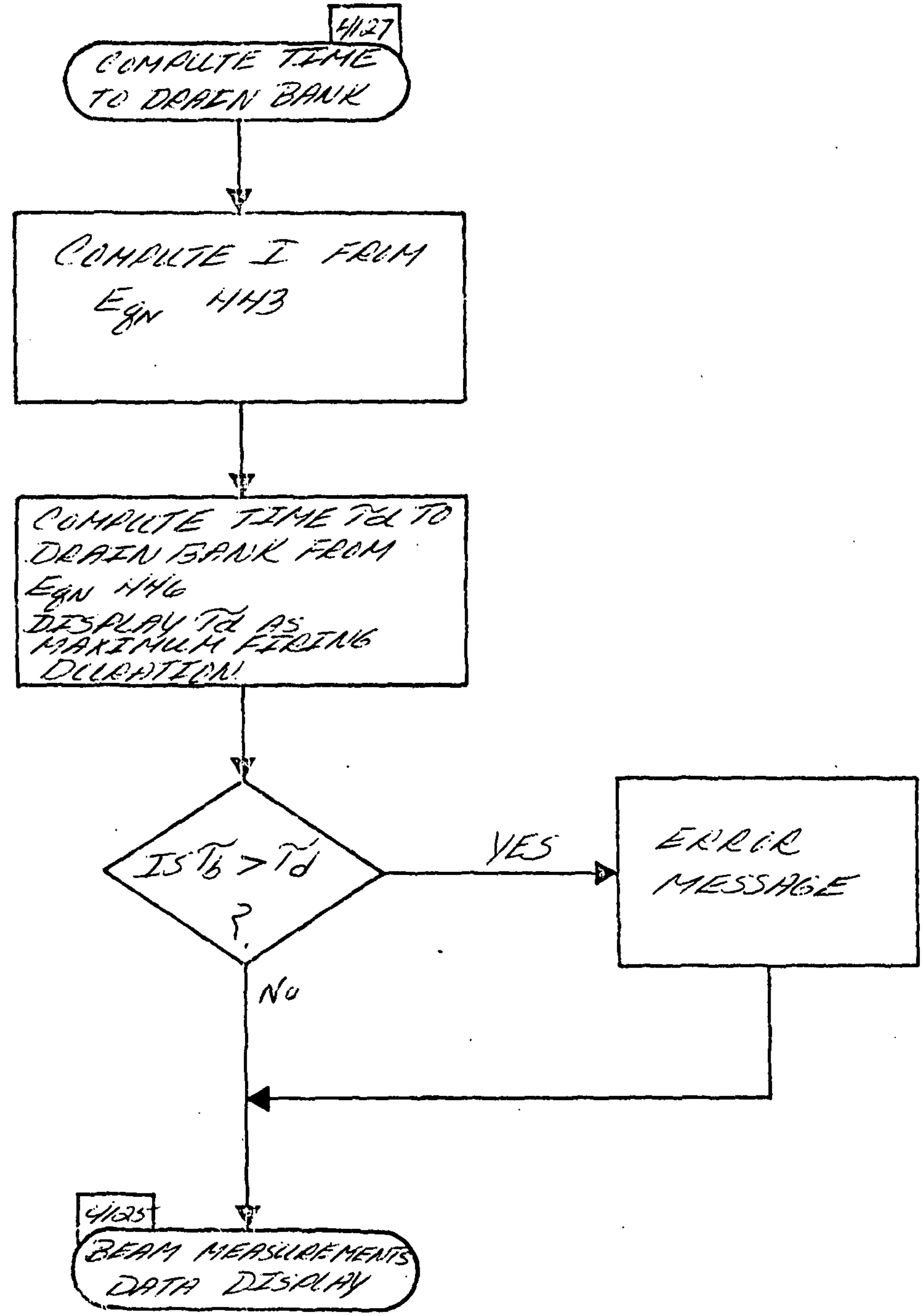
Functional Description

This flowchart shows the computations of the cup current Ic and of the parameters supporting this computation, during the firing time τb, 100 samples of the cup current are obtained. The computation of the loss of energy from the storage bank for this firing is done on a single point only.



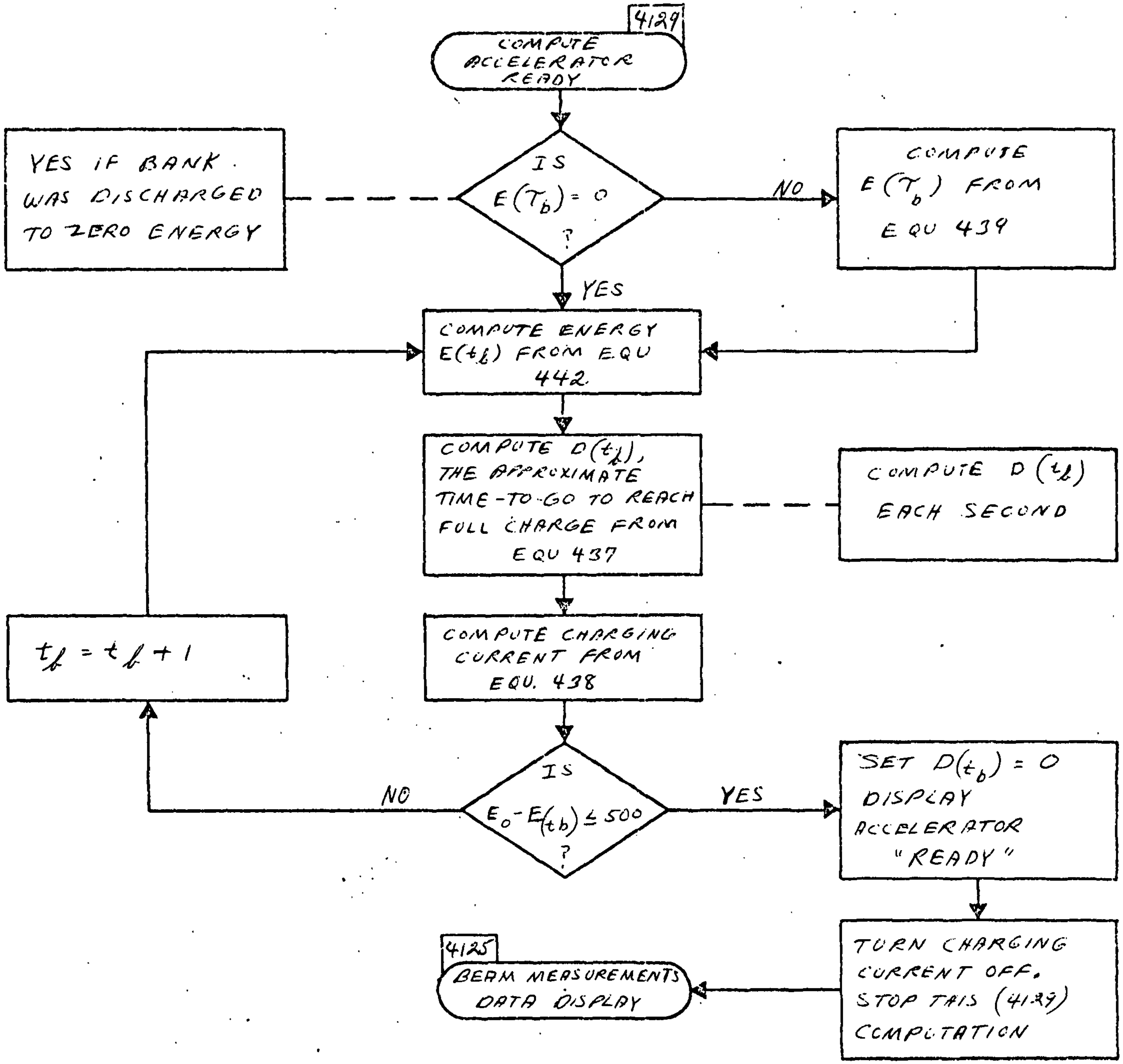
Functional Description

This flowchart shows the computation of the τd time required to drain the energy storage bank at a certain current I and voltage level P. If the planned firing time τb exceeds τd an error message is shown.



Functional Description

This flowchart shows the computation of the time-to-go at which the full charge will be reached. Because of non-linearity of the equations, the time-to-go functions D(t) is an approximate measure of the time required to charge the storage Bank. Charging is continued until Et_b is within 500 Joules of full charge. The flow is idealized in that it assumes no leakage from the storage bank. This computation 4129 is reactivated after each firing unless charging current is turned OFF. Charging computations are continued whether or not display 4125 is activated, until storage bank is full or charging current turned off.



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6.5 LIDAR TRACE OF ACOUSTICAL GRAVITY WAVES IN THE SODIUM LAYER

(The procedure for this experiment is given in Section 3.5.2 of the Final Report.)

The key display for this experiment is Display No. 14, which initializes and maintains the orbit, as well as permitting the experimenter to set up the lidar transmitter, receiver and to make his measurements and recordings. In this experiment it is assumed that the lidar is pointing toward the geocenter. Once again the instrument setups are flowcharted on a building block basis but this time the building blocks have been even more finely divided in that the lidar transmitter (915) and receiver (925) setup displays have been placed in separate blocks.

To set up the transmitter there has been added special tests of absorption cell readiness (Display No. 9195), transmitter output spectrum calculation (Display No. 9175), and other checks (photon count, etc.). However the sodium layer measurements themselves are again combination displays where the experimenter can make repeated firings and decide whether or not to record the results, or else change the altitude limits, and altitude resolution (Display No. 945). This experiment gives the experimenter considerable latitude in his choice of output measurement displays, there being four different choices given (Display No's. 9435, 9445, 9455, and 9465).

6.5.1 Definition of Variables for Lidar Trace of Acoustical Gravity Waves in the Sodium Layer

The following definitions define variables used in the flowcharting that follows. For a more comprehensive understanding of the equations involved see the main body of the Final Report.

P_L	Power Level of flashlamp in Watts. Range 0 to 1000 Watts. Least Count 1 Watt.
P_E	Energy in a Single Pulse in Joules. Range 0.1 to 10.0 Joules. Least Count 0.1 Joule.
T_R	Time Interval between start of successive laser firings in seconds. Range 0.1 to 100 seconds. Least Count 0.1 second.
FS	Field Stop Value. Range 0.01 to 100.00 milliradians. Least Count .01 milliradian.

BD	Transmitted Beam Divergence. Range 0.01 to 10.00 milliradians. Least Count 0.01 milliradian.
BT	Range of Wavelength of Spectrometer. Range 300 to 800 nM. Least Count 0.1 nM.
FT	Tine Tune Capability of Fabry-Perot. Range Least Count 0.01 nM.
RES	Resolution achievable by Spectrometer. Range 10,000 to 0.001 nM. Least Count 0.001 nM.
Top	Absorption Cell Operating Temperature. Range 100 to 1000^{o}C. Least Count 1^{o}C.
Z	Altitude of atmosphere observed as measured from earth surface. Range 0 to 500 KM. Least Count 0.01 KM.
ΔZ	Altitude Resolution element being observed. Range 10^2 to 10^5 meters. Least Count 10 meters.
Xo	Value of X at N (number of firings) = 0.
X	Distance measured along orbiter circle of altitude at orbiter altitude between Greenwich Meridian Plane and current orbiter position. Measured Eastward from Greenwich Meridian Plane.
UTH	Greenwich Mean Time in Decimal Hours.
λ_{ℓ}	Center wavelength of wavelength spectrum transmitted.
RES_{FP}	Receiver Resolution Element. Range 100.000 nm to 0.001 nm Least Count 0.001 nm.
AP	Receiver Aperture Setting. Range 0 to 100 Least Count 1.
$P\lambda$ min, $P\lambda$ max	Minimum and maximum wavelengths of the transmitter pulse.
η	Angle between altitude and distance axes, degrees Range 30° to 80°. Least Count 1°.

Ox, Oy	x, y coordinates of origin on MFDS CRT display screen for N = 0.
N	Number of laser firings contributing to an output display.
S	Scale value at which tic mark will be displayed on graphic display axis.

6.5.2 Typical Values of Lidar Trace of Acoustical Gravity Waves in the Sodium Layer

The following values of parameters are considered typical, and may, for example, be used as default values.

	ORBITER ATTITUDE, ALTITUDE, INCLINATION
Γ	180 Degrees
Λ	180 Degrees
Δ	0 Degrees
H	180 Kilometers
i	27 Degrees

	LASER PARAMETERS
P_L	1000 Watts
P_E	10.0 Joules
T_R	1.00 Hz
BD	1.00 Milliradians
FS	100 Milliradians
BT	589.0 Nanometers

RES	10 Nanometers
RES_{FP}	0.01 Nanometers
FT	50
$P\lambda$ max	590 Nanometers (Power Meter Upper Limit)
$P\lambda$ min	580 Nanometers (Power Meter Lower Limit)
$\lambda 1$	588.99 Nanometers
% Absorption Cell Transmission	80%
AL	0.00 Degrees Transmitter Azimuth Alignment
EL	0.00 Degrees Transmitter Elevation Alignment
ΔZ	0.1 KM
Z Minimum Value	80 KM
Z Maximum Value	100 KM
λmin	300 Nanometers Lower Limit of Laser Transmission
λmax	800 Nanometers Upper Limit of Laser Transmission
Angle +Z Axis to Nadir	0 Degrees
Top	800 Degrees Celsius

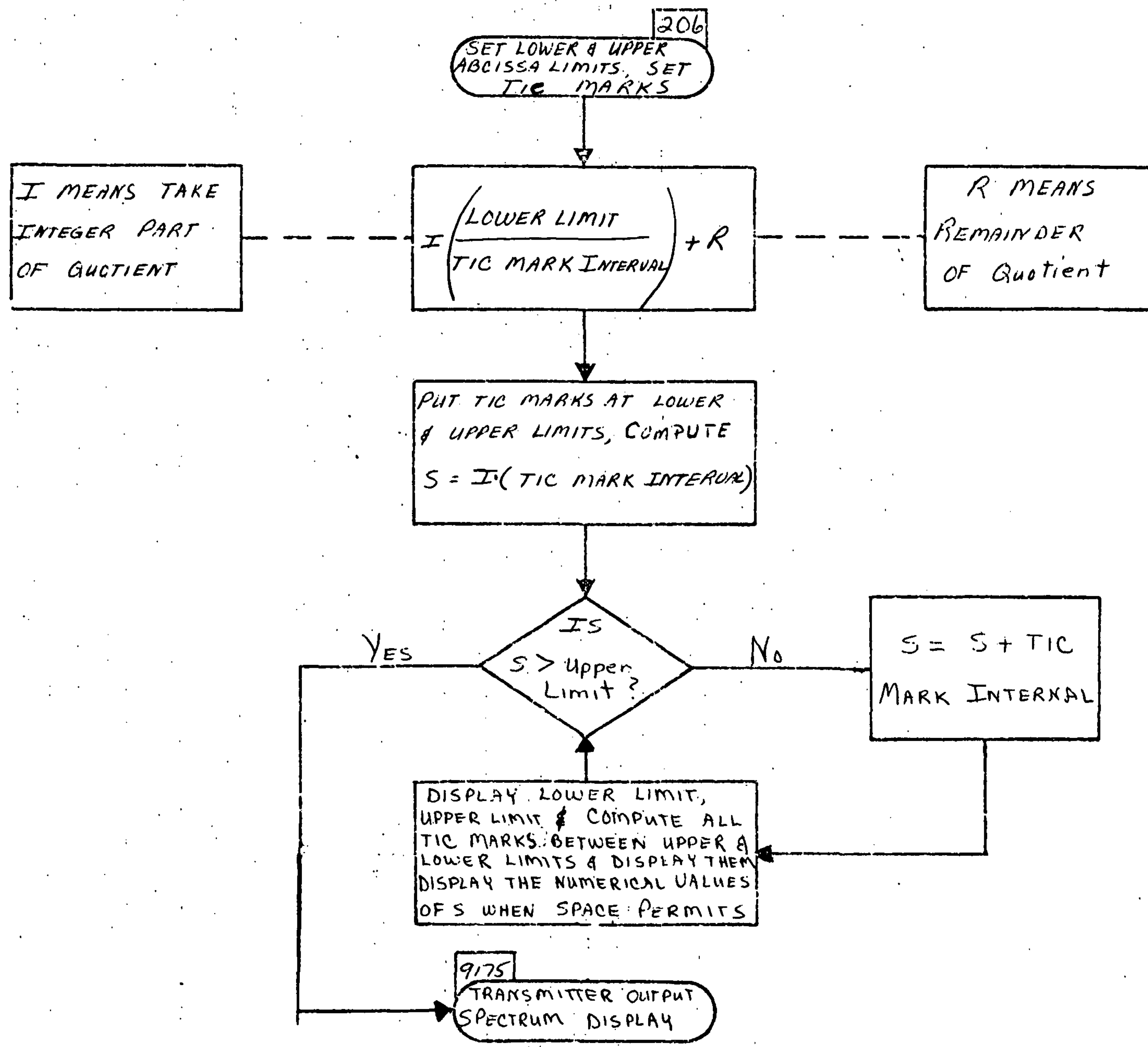
6.5.3 FLOWCHARTS AND DISPLAY FORMATS FOR

LIDAR TRACE OF ACOUSTICAL GRAVITY WAVES IN THE SODIUM LAYER

Functional Description

This flowchart shows the processes in changing the scale of the Abcissa Axis.

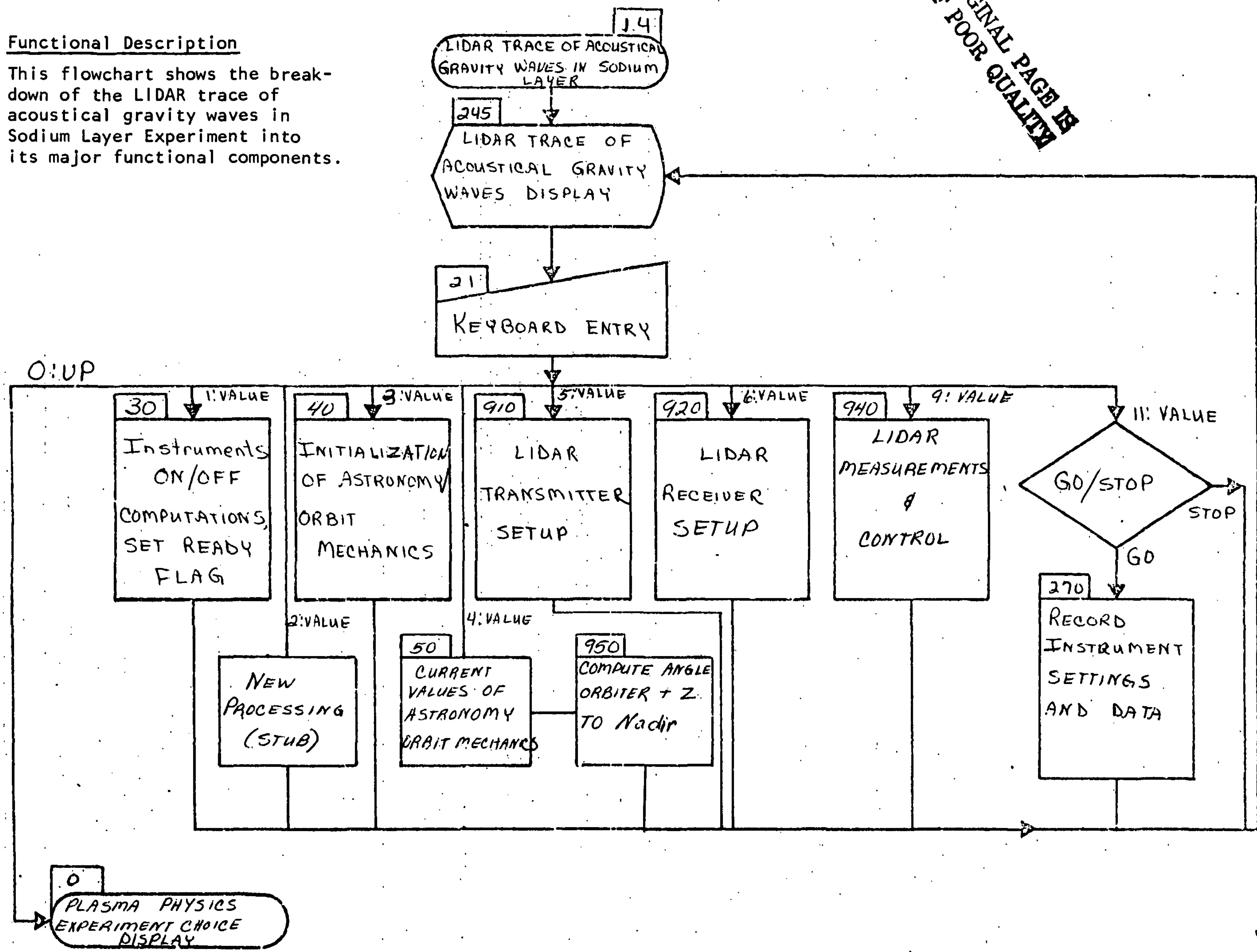
A similar flowchart could be drawn for the Ordinate Axis of a 2-axis display.



C.3

Functional Description

This flowchart shows the breakdown of the LIDAR trace of acoustical gravity waves in Sodium Layer Experiment into its major functional components.



245 LIDAR TRACE OF ACOUSTICAL
GRAVITY WAVES IN SODIUM LAYER

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO PLASMA PHYSICS EXPERIMENT

1: LIDAR EXPERIMENT INSTRUMENTS ______ ON/OFF

[ ] READY

2: SPARE

3: INITIALIZATION OF ASTRONOMY/ORBIT MECHANICS ______ I/D

4: CURRENT VALUES OF ASTRONOMY/ORBIT MECHANICS ______ I/D

5: LIDAR TRANSMITTER SETUP ______ I/D

6: LIDAR RECEIVER SETUP ______ I/D

7: SPARE

8: SPARE

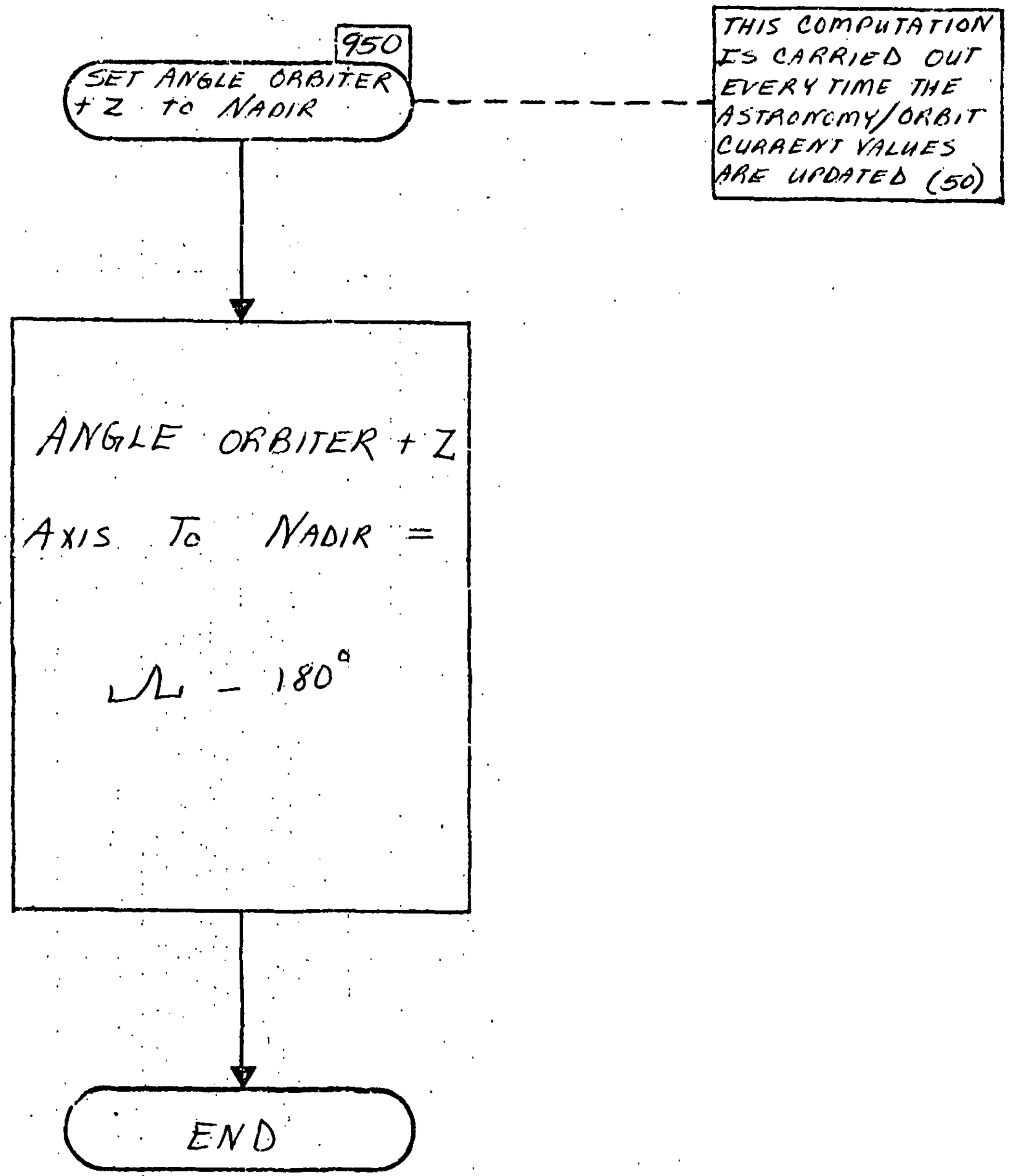
9: LIDAR MEASUREMENTS & CONTROL ______ I/D

10: SPARE

11: RECORD INSTRUMENT SETTINGS & DATA ______ GO/STOP

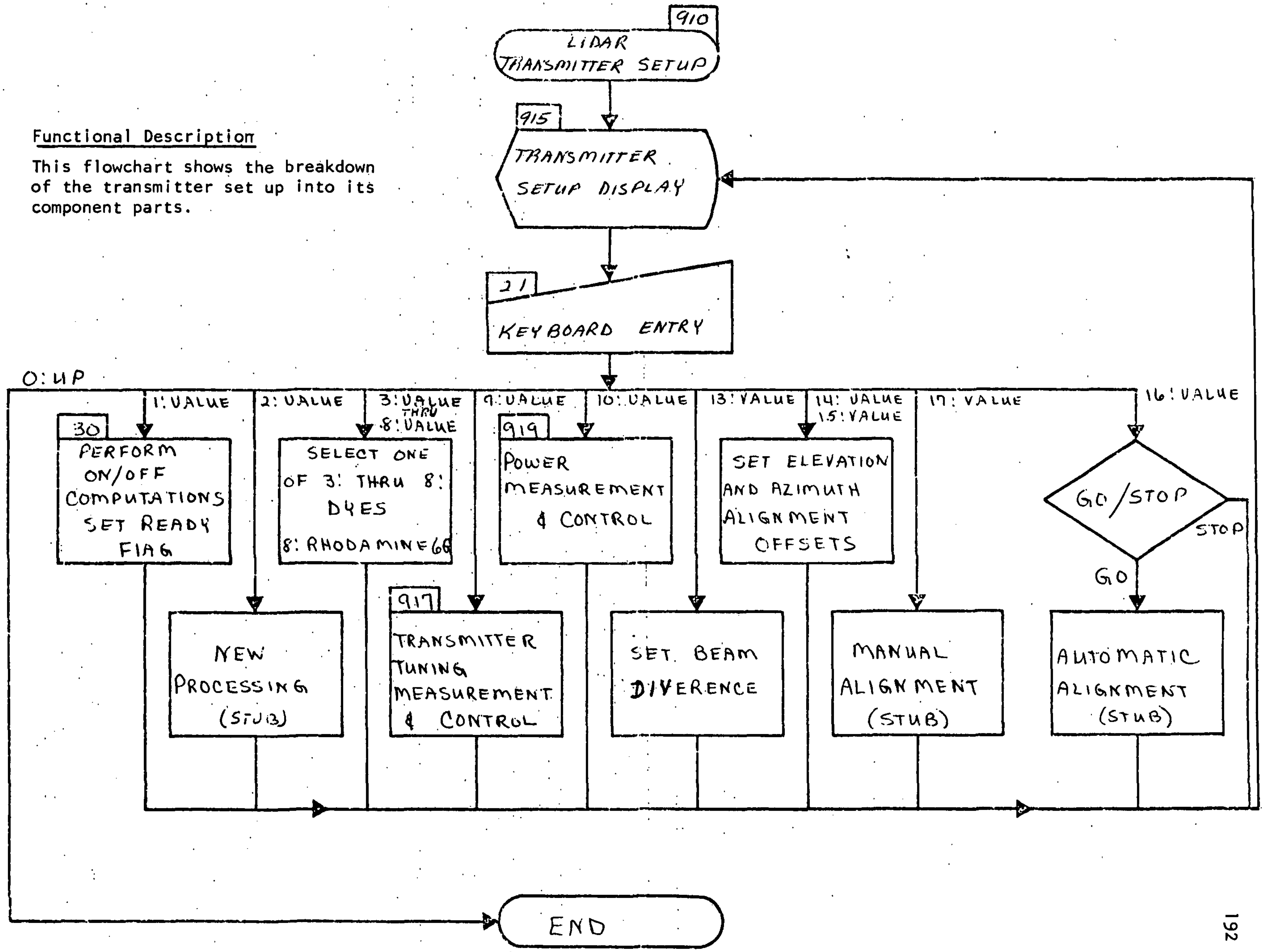
Functional Description

This simple computation is carried out to assure the experimenter that the laser beam which is aligned to the Orbiter +Z axis will be pointing always to the Earth's center.



Functional Description

This flowchart shows the breakdown of the transmitter set up into its component parts.



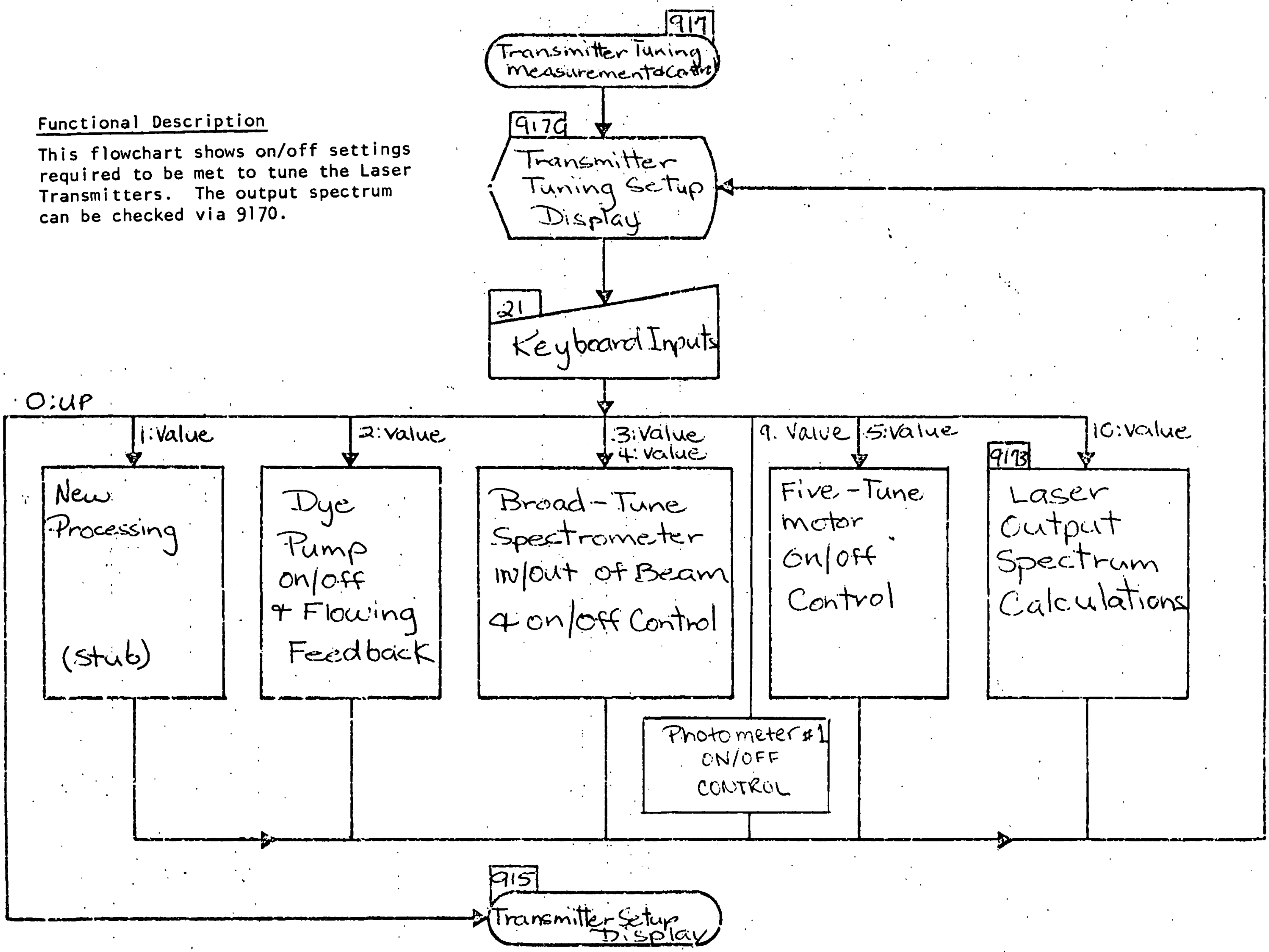
915 LIDAR TRANSMITTER SETUP DISPLAY

ERROR MSG:

0: PROCEDURE	_____ UP/I/D	10: POWER MEASUREMENT AND CONTROL	_____ I/D
1: SPARE		11: SPARE	
2: LIDAR TRANSMITTER INSTRUMENTS	_____ ON/OFF	12: SPARE	
	☐ READY	13: SET BEAM DIVERGENCE	_____ XX.XX MILLIRADIANS
DYES			
		14: SET AZIMUTH ALIGN (AL)	_____ X.XX DEGREES
3: SPARE			
		15: SET ELEVATION ALIGN (EL)	_____ X.XX DEGREES
4: SPARE			
5: SPARE		16: AUTOMATIC ALIGNMENT	_____ GO/STOP
6: SPARE		17: MANUAL ALIGNMENT	_____ I/NO/D
7: SPARE			
8: RHODAMINE 6 G	_____ YES/NO		
CONTROL AND ALIGNMENT			
9: TUNING MEASUREMENT AND CONTROL	_____ I/D		

Functional Description

This flowchart shows on/off settings required to be met to tune the Laser Transmitters. The output spectrum can be checked via 9170.



9120 TRANSMITTER TUNING
SETUP DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO TRANSMITTER SETUP DISPLAY

1: SPARE

2: DYE PUMP ______ ON/OFF

☐ FLOWING

3: BROAD-TUNE GRATING ______ IN/OUT OF BEAM

4: BROAD-BAND SPECTROMETER ______ ON/OFF

5: FINE-TUNE MOTOR ______ ON/OFF

6: SPARE

7: SPARE

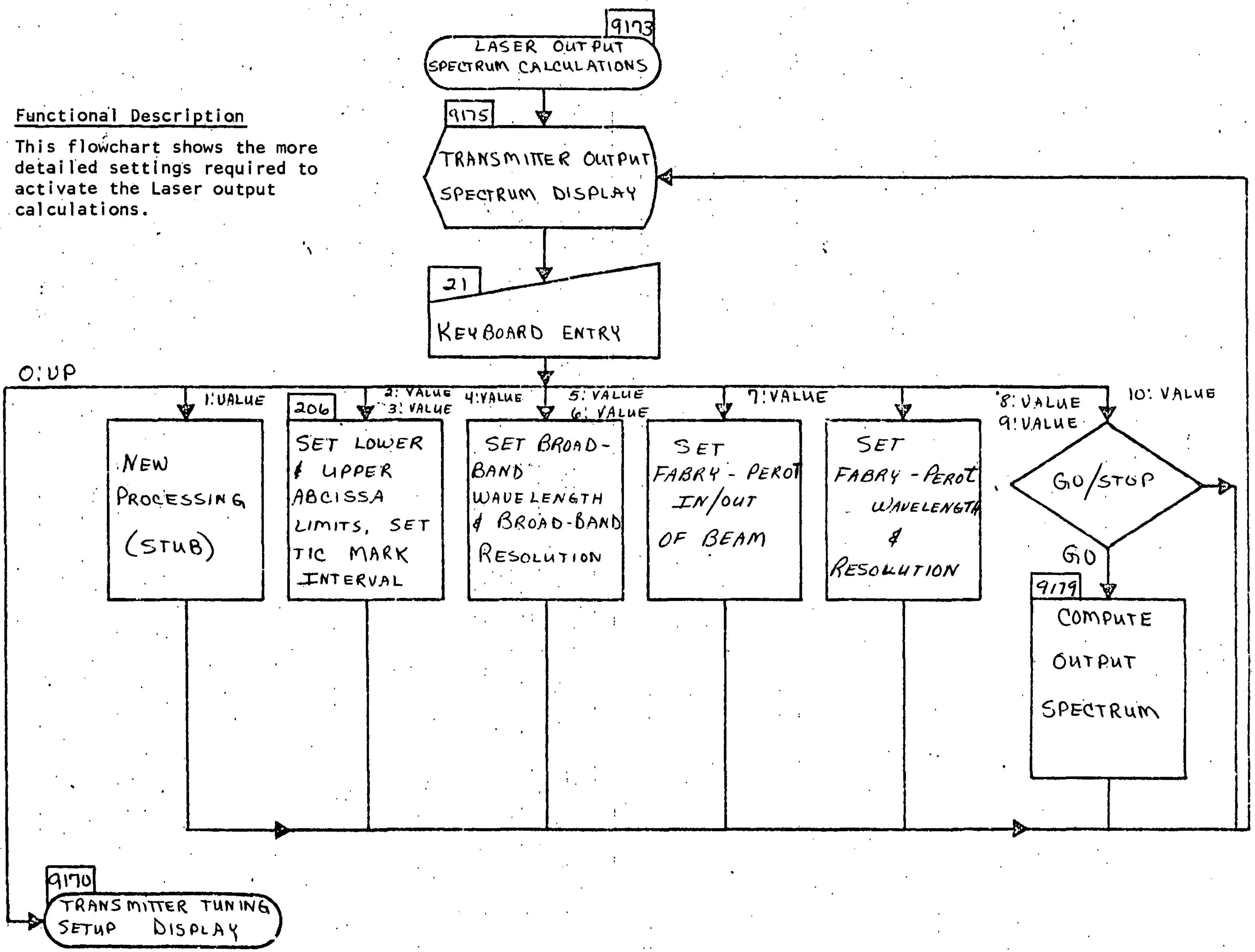
8: SPARE

9: PHOTOMETER #1 ______ ON/OFF

10: LASER OUTPUT SPECTRUM CALCULATIONS ______ I/D

Functional Description

This flowchart shows the more detailed settings required to activate the Laser output calculations.



9175 TRANSMITTER OUTPUT SPECTRUM DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO TRANSMITTER TUNING SETUP DISPLAY

1: SPARE

2: LOWER WAVELENGTH LIMIT ______ XXX.X nM

3: UPPER WAVELENGTH LIMIT ______ XXX.X nM

4: TIC MARK INTERVAL ______ XXX.X nM

5: BROAD-BAND WAVELENGTH ______ XXX.X nM

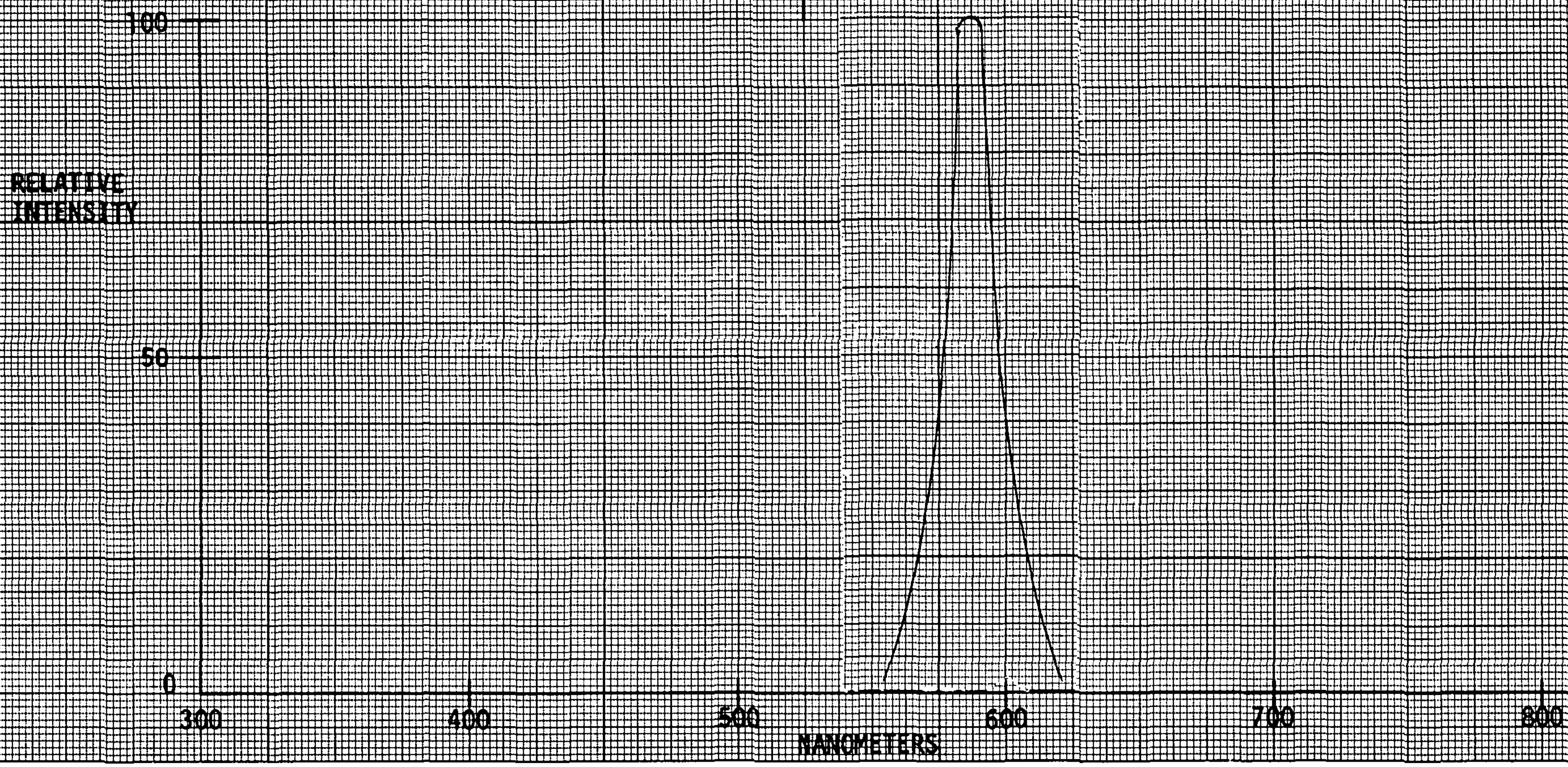
6: BROAD-BAND RESOLUTION ______ XX.X nM

7: FABRY-PEROT ______ IN/OUT OF BEAM

8: FABRY-PEROT WAVELENGTH ______ XXXX.XX nM

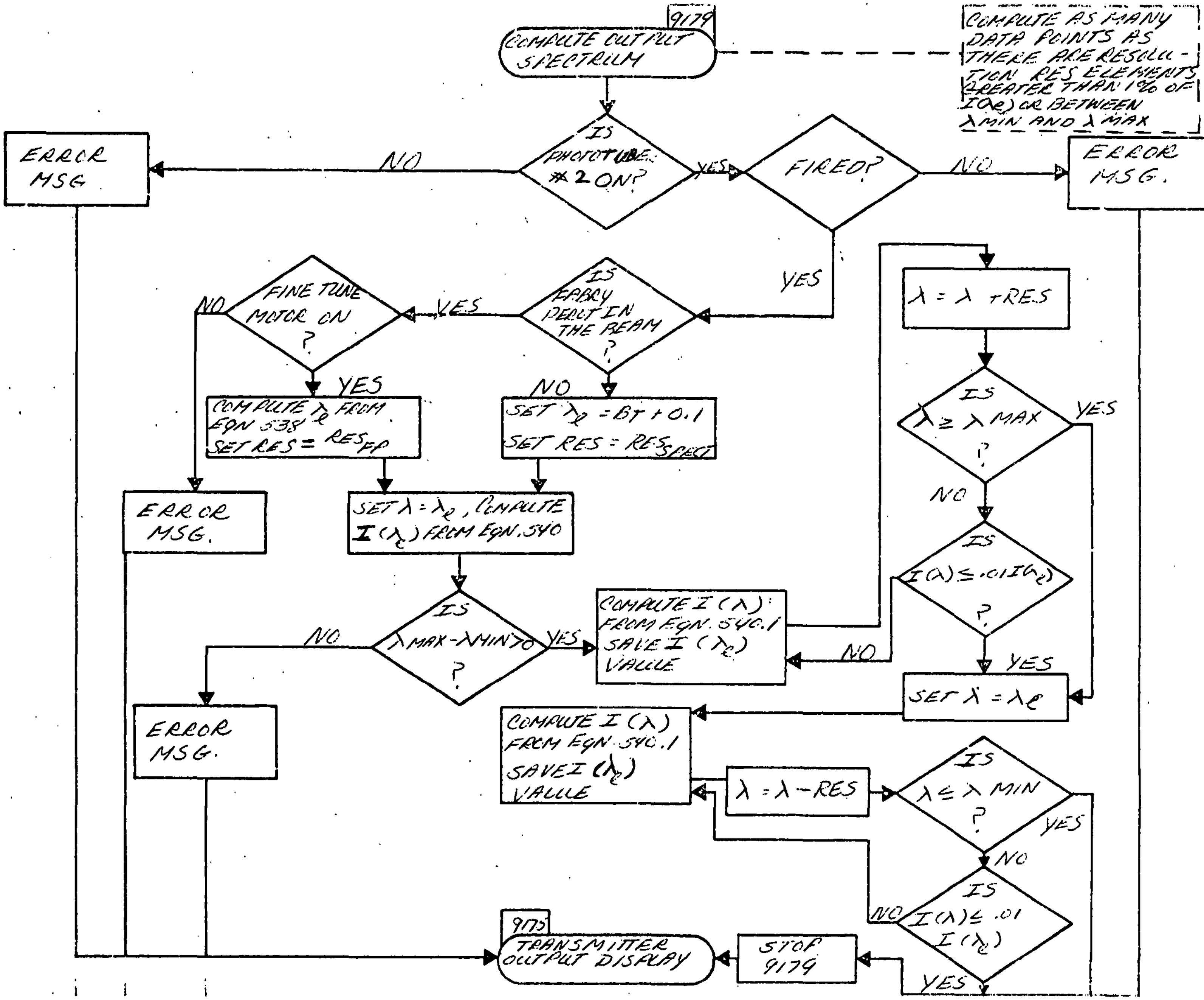
9: FABRY-PEROT RESOLUTION ______ X.XX nM

10: COMPUTE OUTPUT SPECTRUM ______ GO/STOP



Functional Description

This flowchart shows the detailed computations of the output spectrum produced by the transmitter, whether the Fabry-Pero t is in the beam or out of the beam. The computation is started at λ_ℓ and proceeds until the computation either passes the λmax, λmin limits or the .01 $I(\lambda_\ell)$ limit, to avoid computing an excessive number of points.



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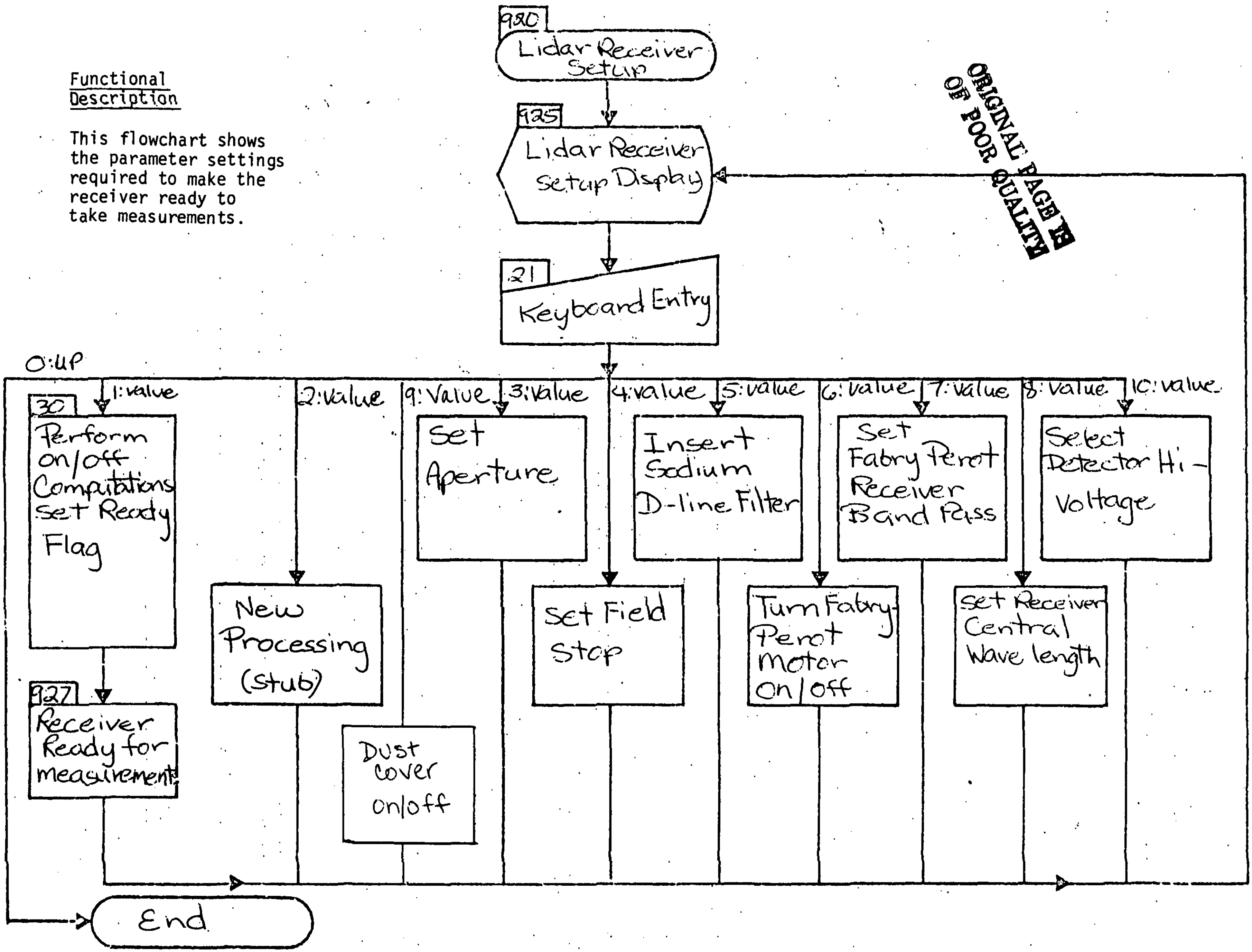
Functional Description

This flowchart shows the parameter settings required to make the receiver ready to take measurements.



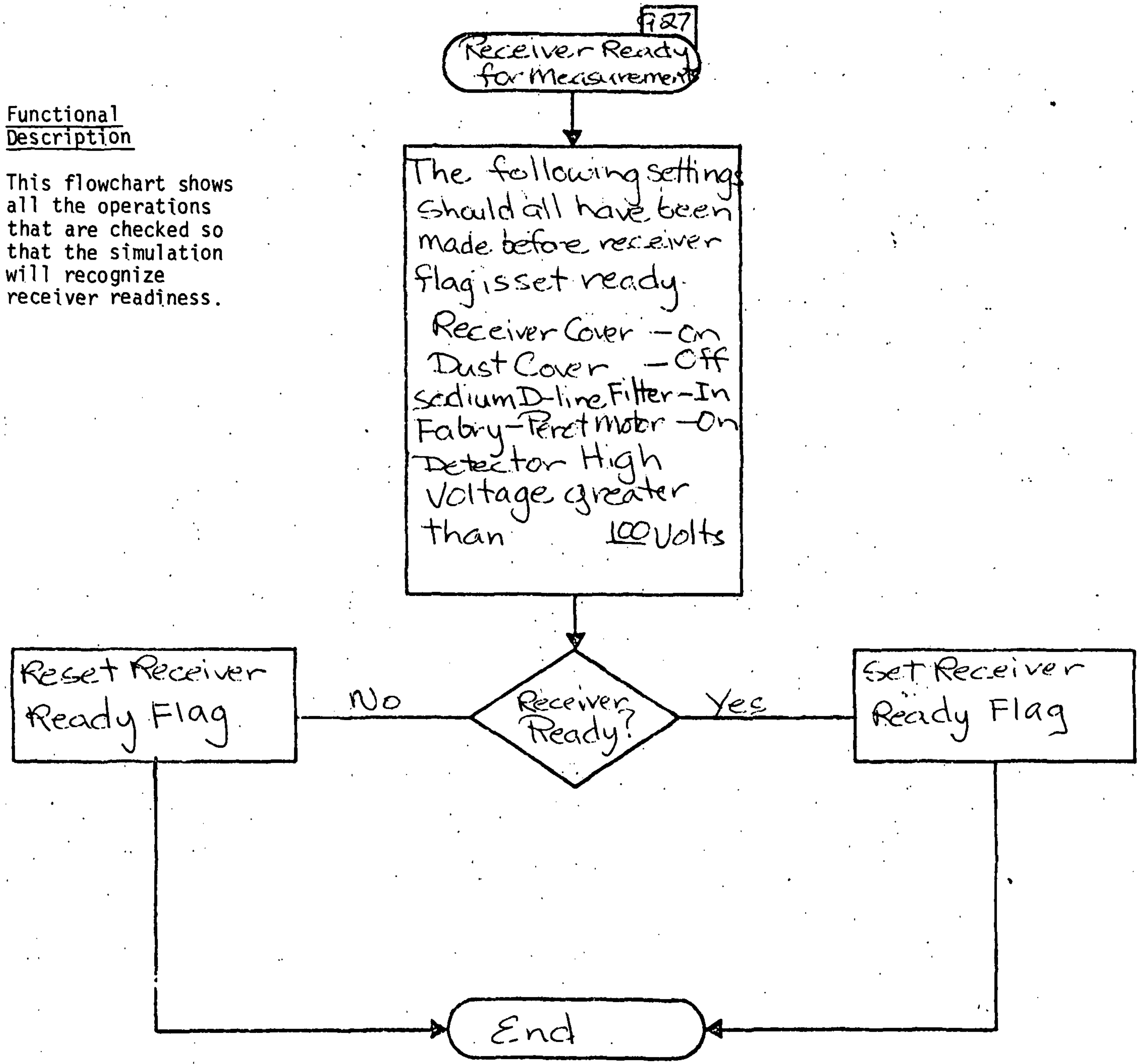
925 LIDAR RECEIVER SETUP DISPLAY

ERROR MSG:

0:	PROCEDURE UP TO ________	____	UP/I/D
1:	LIDAR RECEIVER	____	ON/OFF
	WARMED UP	☐	READY
2:	SPARE		
3:	SET APERTURE	____	XXX DIAMETER
4:	SET FIELD STOP	____	XXX.X MILLIRADIANS
5:	SODIUM D-LINE FILTER	____	IN/OUT OF THE BEAM
6:	FABRY-PEROT MOTOR	____	ON/OFF
7:	SET FABRY-PEROT RECEIVER BAND-PASS (RES$_{FP}$)	____	X.XXX mM
8:	SET RECEIVER CENTRAL WAVELENGTH	____	XXX.XX mM
9:	DUST COVER	____	ON/OFF
10:	SELECT DETECTOR HI-VOLTAGE	____	XXXX VOLTS
	RECEIVER READY FOR MEASUREMENTS	☐	READY

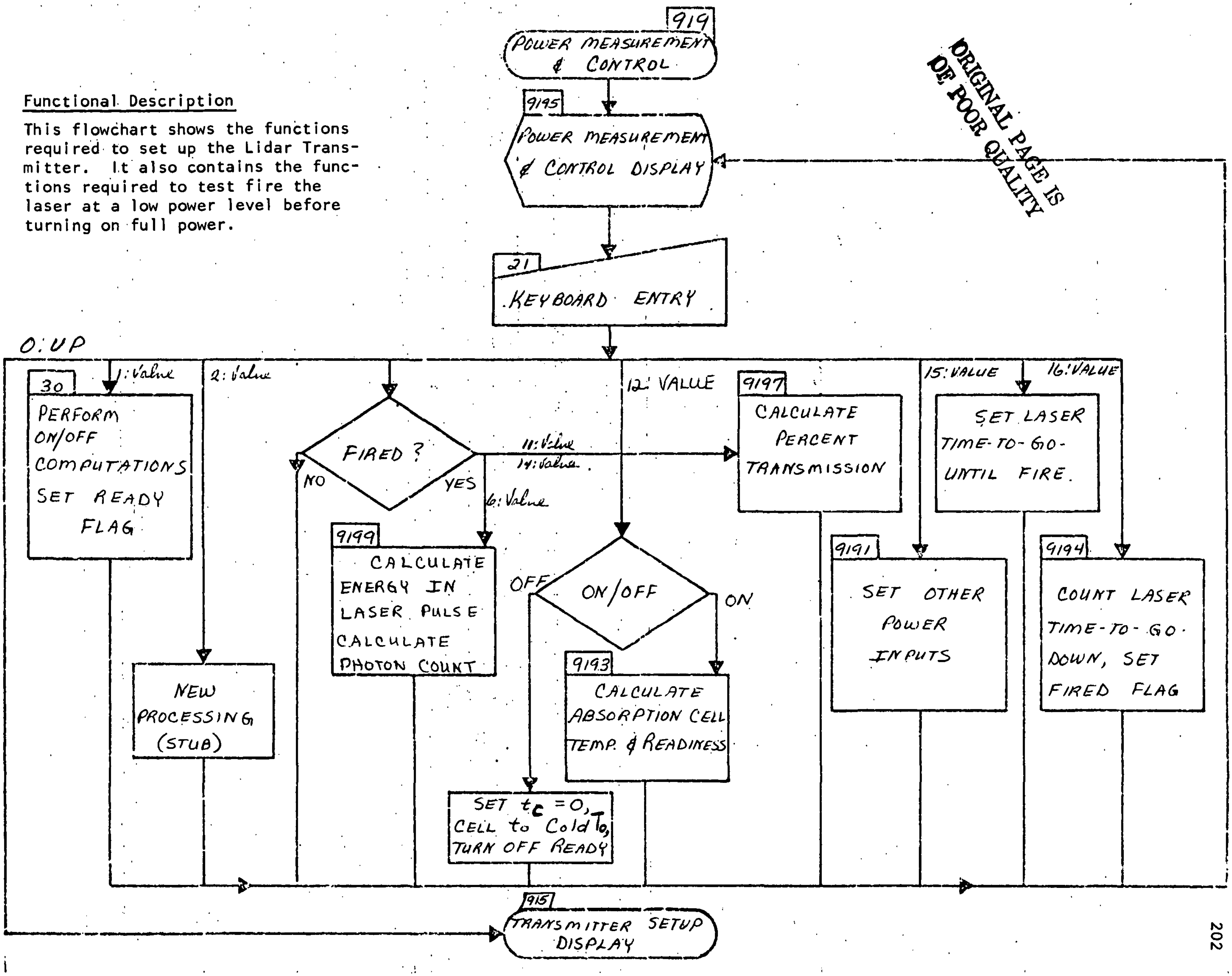
Functional
Description

This flowchart shows all the operations that are checked so that the simulation will recognize receiver readiness.



Functional Description

This flowchart shows the functions required to set up the Lidar Transmitter. It also contains the functions required to test fire the laser at a low power level before turning on full power.



9195 POWER MEASUREMENT AND
CONTROL DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO TRANSMITTER SETUP DISPLAY

LASER POWER

1: LASER POWER SUPPLY ______ ON/OFF
[ ] READY

2: SPARE

3: LASER POWER LEVEL ______ XXXX WATTS

4: LASER PULSE ENERGY ______ XX.X JOULES

5: LASER PULSE FREQUENCY ______ X.XX Hz

POWER METER

6: CALCULATE ENERGY IN LASER PULSE ______ GO/STOP

PULSE ENERGY [ ] JOULES

7: POWER METER ______ ON/OFF

8: SPARE

9: SET LOWER WAVELENGTH Pλ MAX ______ XXXX.nM

10: SET UPPER WAVELENGTH Pλ MIN ______ XXXX.nM

ABSORPTION CELL

11: ABSORPTION CELL ______ IN/OUT OF THE BEAM

12: CELL ON/OFF & CONTROL ______ ON/OFF

13: SET MAX TEMPERATURE ______ XXX CELSIUS

CELL [ ] READY

CELL TEMPERATURE [ ] DEGREES CELSIUS

TRANSMISSION [ ] PERCENT

14: PHOTOTUBE #2 ______ ON/OFF

LASER COUNTDOWN

15: LASER TIME-TO-GO UNTIL FIRE ______ XX SECONDS

16: LASER COUNTDOWN ______ GO/STOP

TIME-TO-GO UNTIL FIRE [ ] SECONDS

PHOTON COUNT

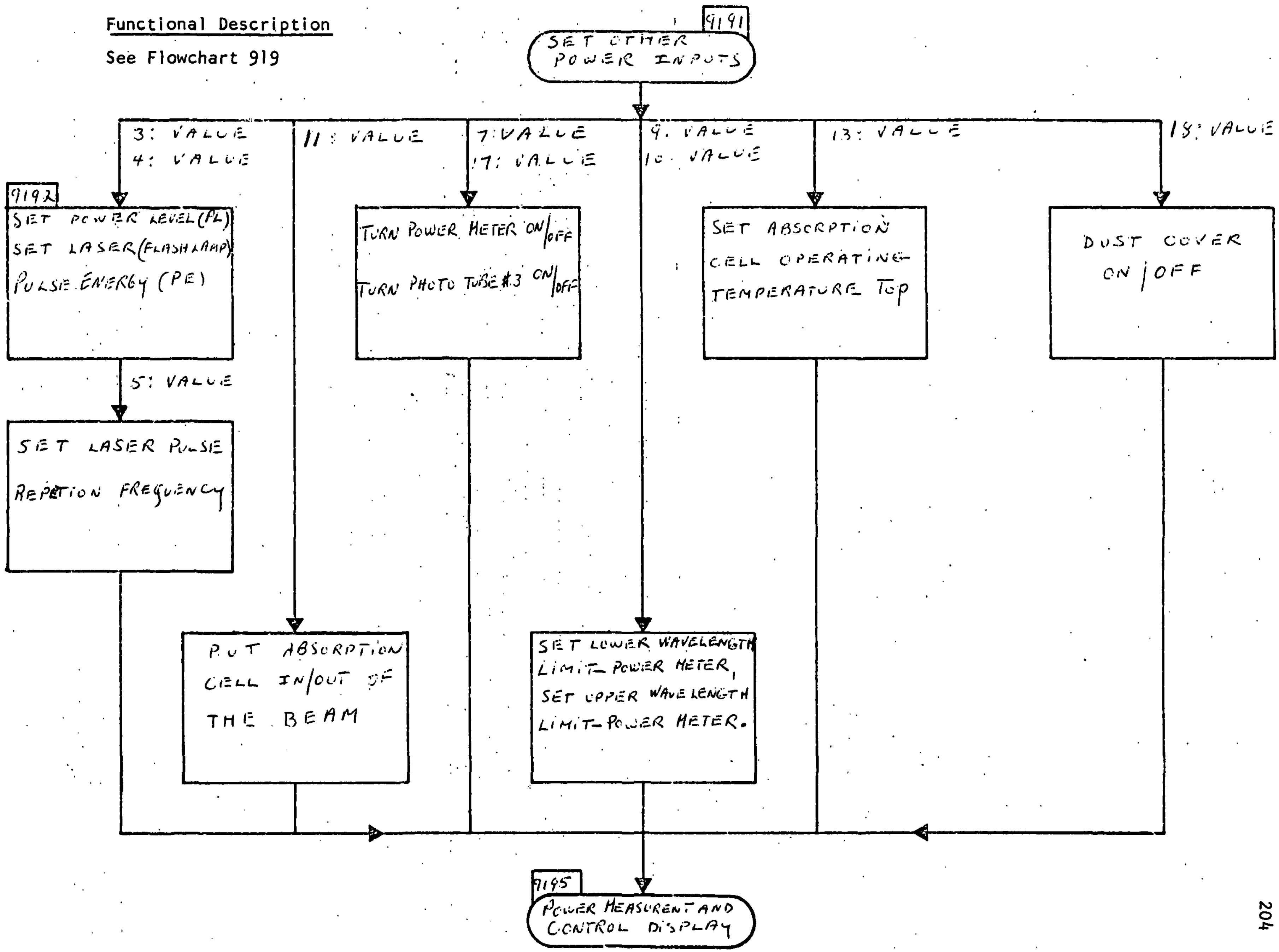
PHOTON COUNT [ ] PHOTONS

17: PHOTOTUBE #3 ______ ON/OFF

18: DUST COVER ______ ON/OFF

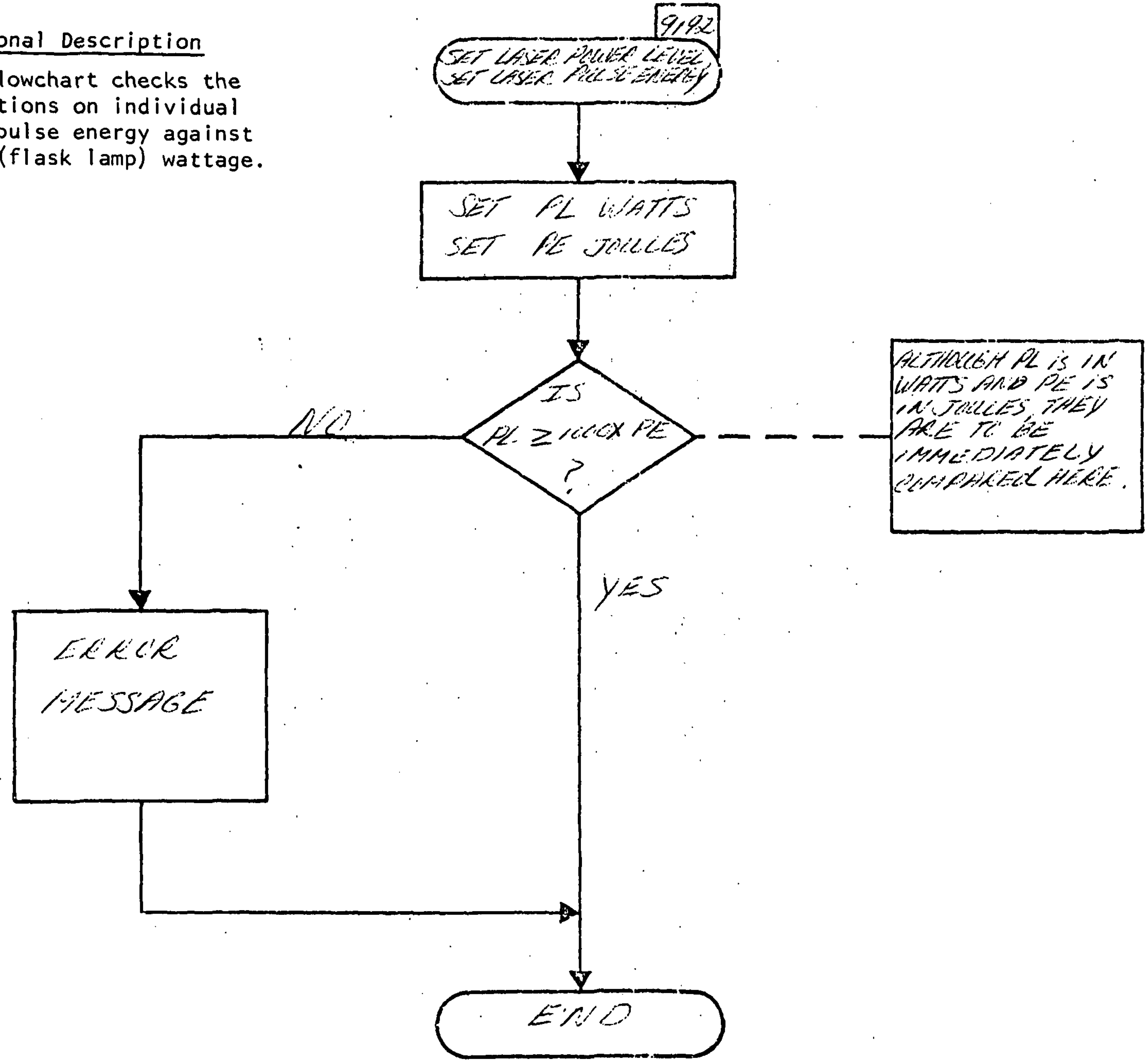
Functional Description

See Flowchart 919



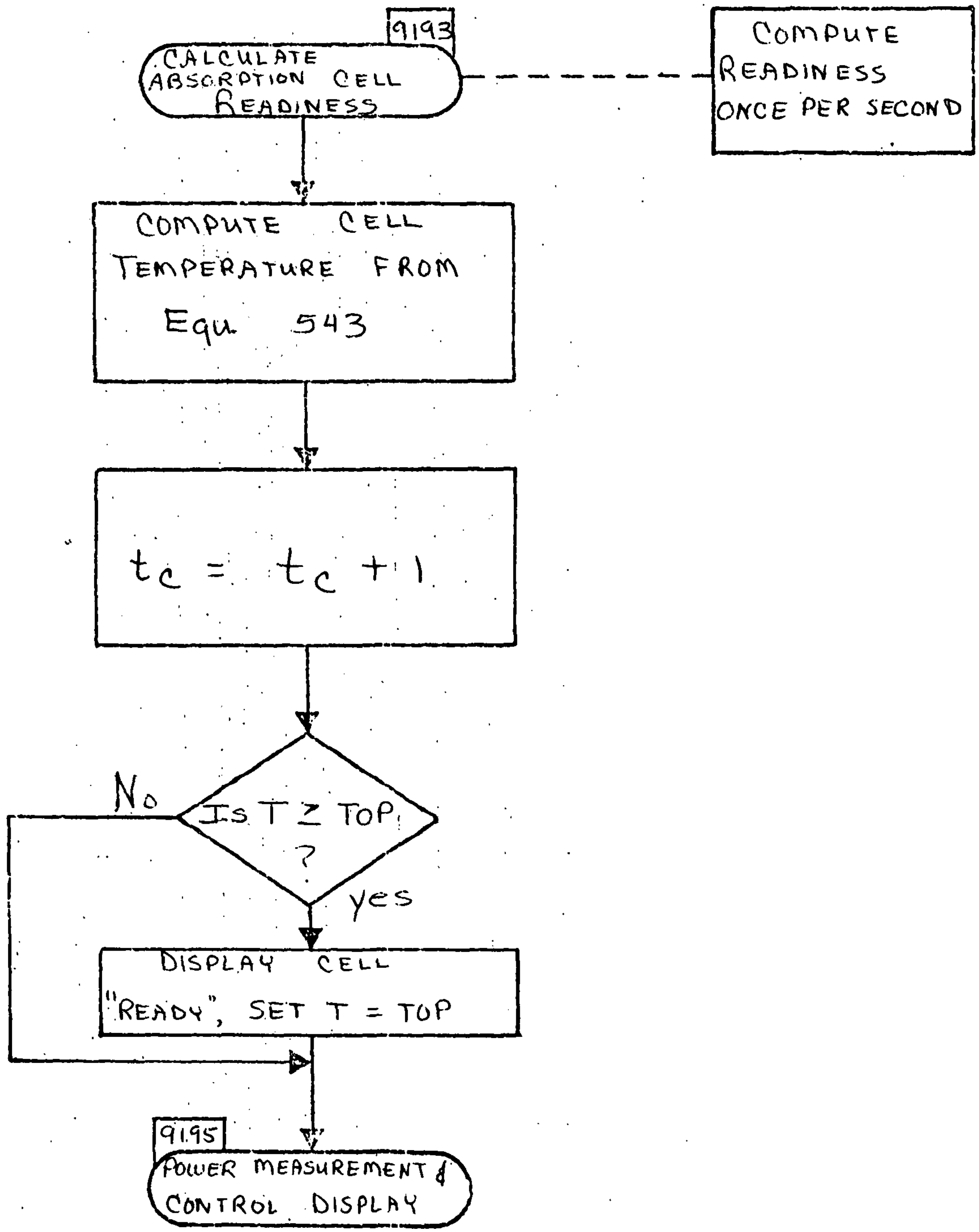
Functional Description

This flowchart checks the limitations on individual laser pulse energy against total (flask lamp) wattage.



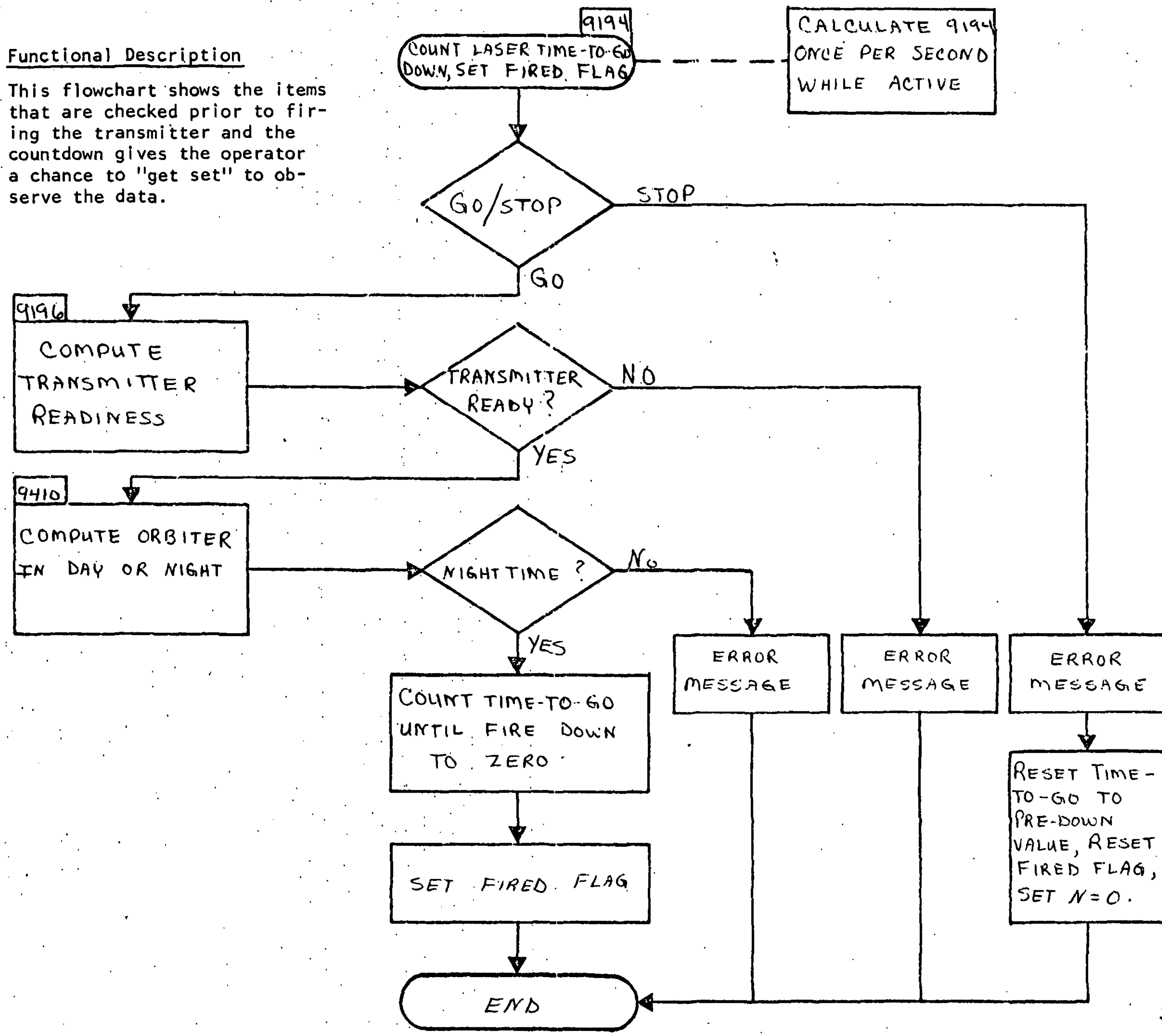
Functional Description

This flowchart shows the simulation of the heating of the absorption cell as a function of time. When the absorption cell has reached the operating temperature, TOP, this is maintained until the cell is turned off.



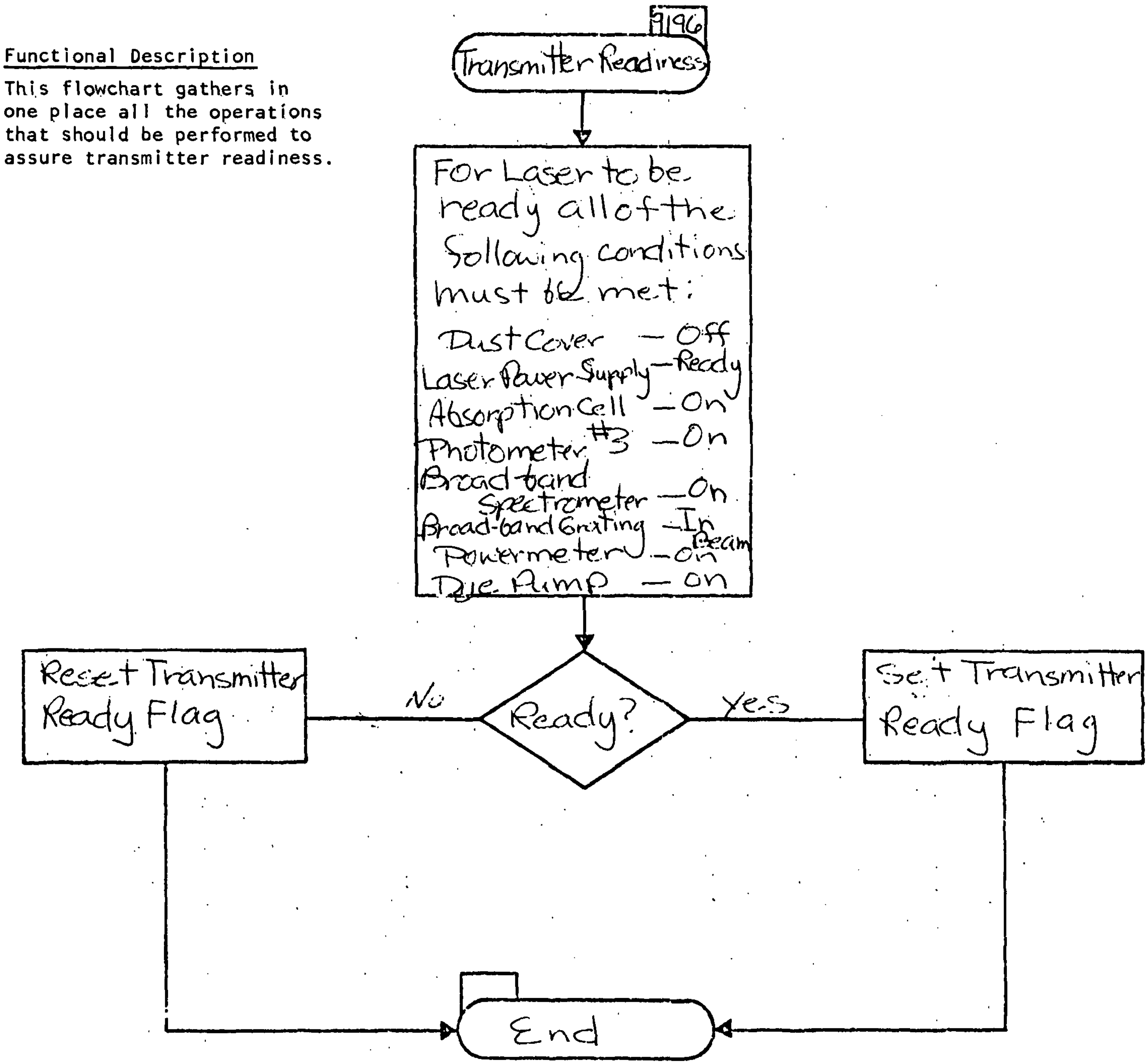
Functional Description

This flowchart shows the items that are checked prior to firing the transmitter and the countdown gives the operator a chance to "get set" to observe the data.



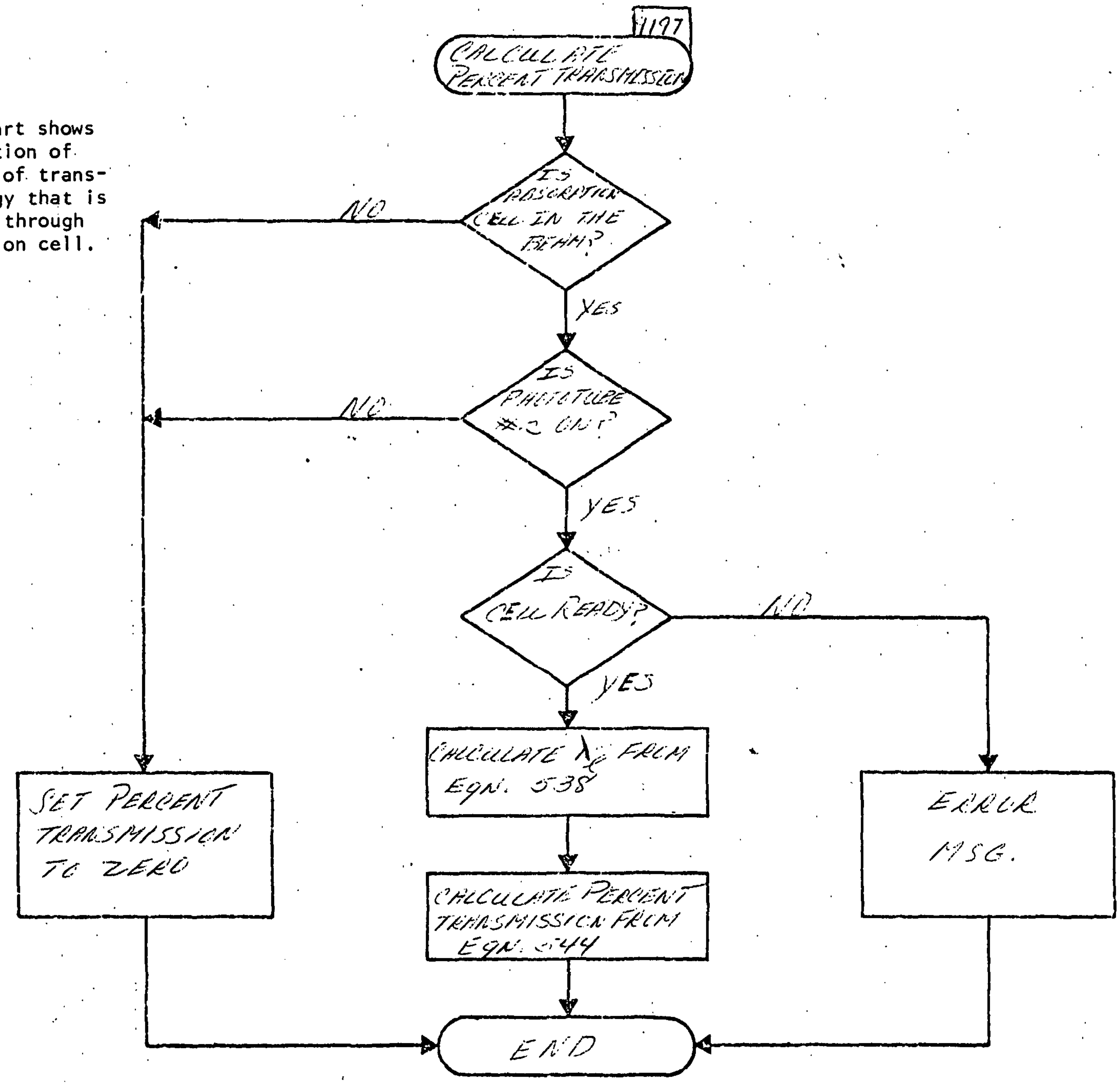
Functional Description

This flowchart gathers in one place all the operations that should be performed to assure transmitter readiness.



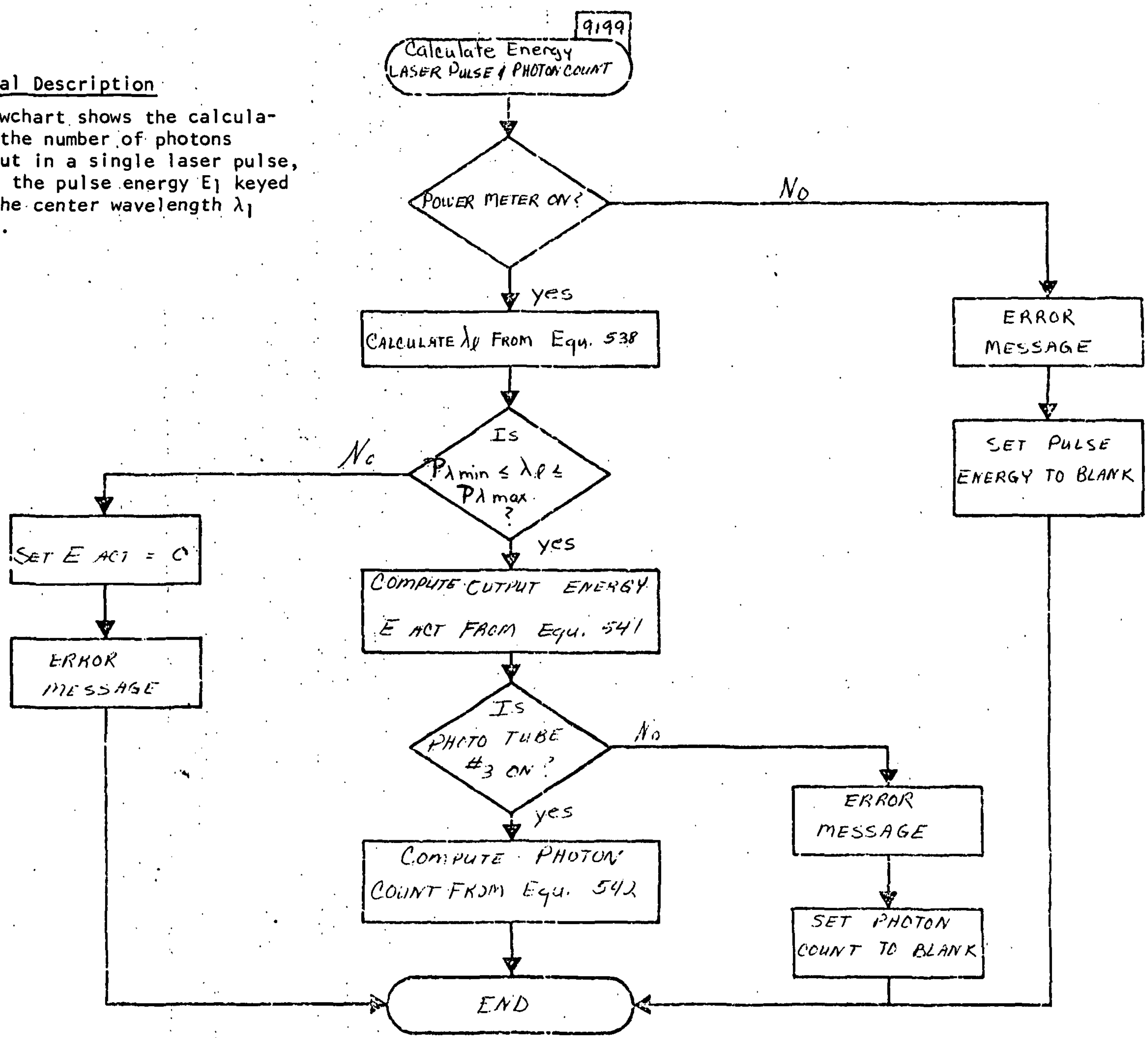
Functional Description

This flowchart shows the computation of the percent of transmitter energy that is transmitted through the absorption cell.



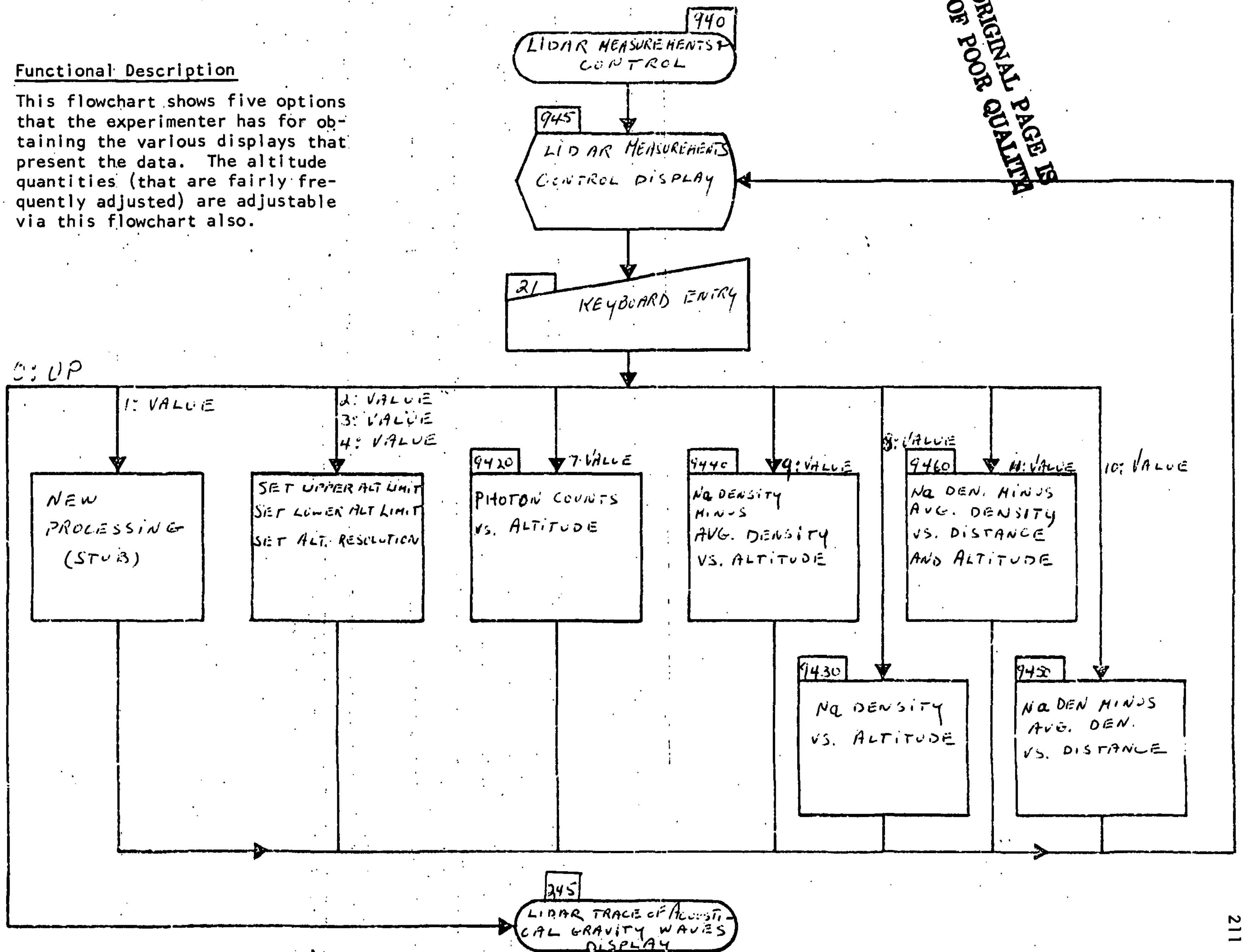
Functional Description

This flowchart shows the calculation of the number of photons N_{ph} output in a single laser pulse, based on the pulse energy E_l keyed in and the center wavelength λ_l selected.



Functional Description

This flowchart shows five options that the experimenter has for obtaining the various displays that present the data. The altitude quantities (that are fairly frequently adjusted) are adjustable via this flowchart also.



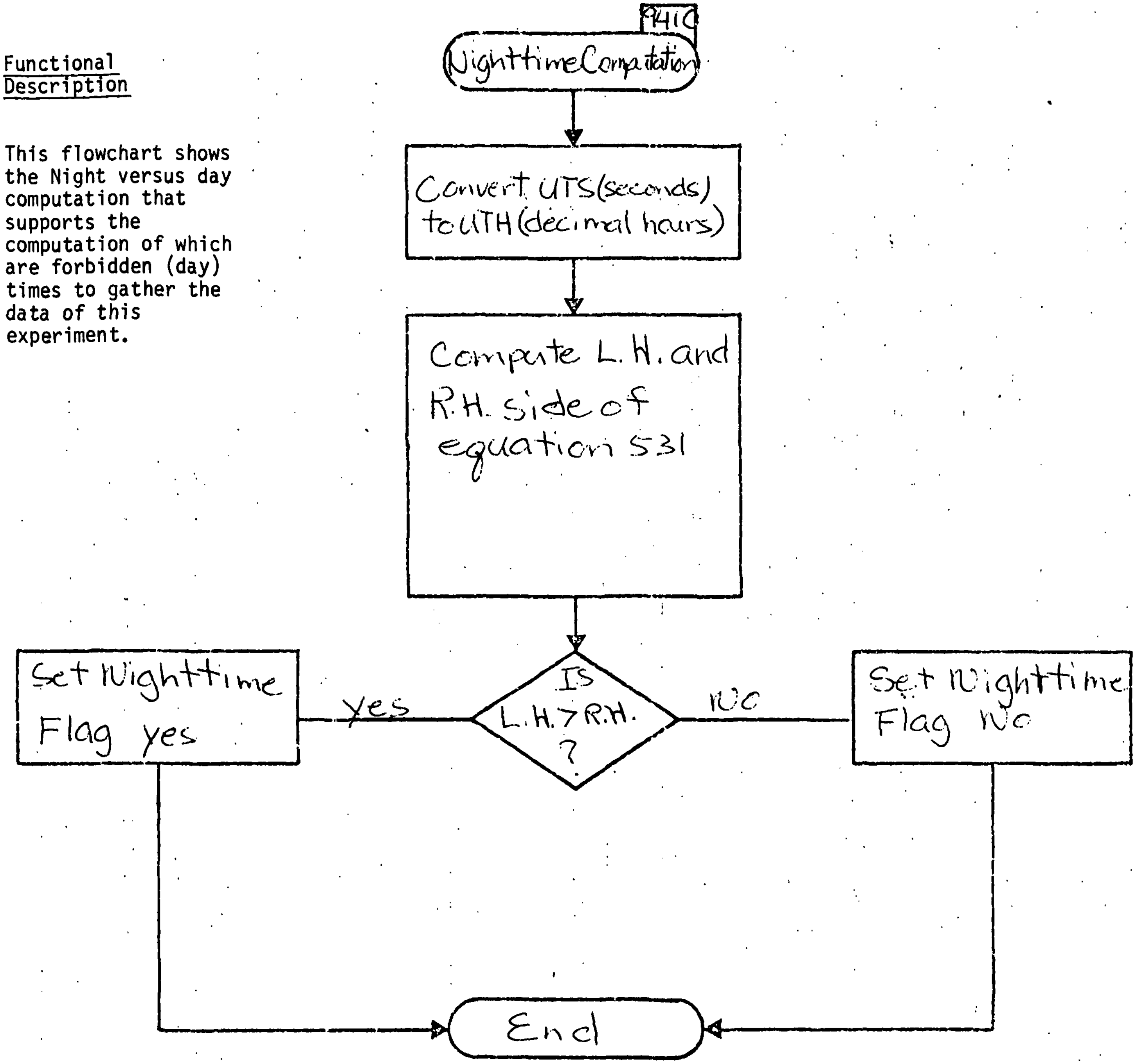
945 LIDAR MEASUREMENTS CONTROL DISPLAY

ERROR MSG:

0: PROCEDURE	______ UP/I/D	LATITUDE	[ ]	DEGREES
1: SPARE		LONGITUDE	[ ]	DEGREES
2: SET UPPER ALTITUDE LIMIT	______ XXX.X Km	LOCAL TIME	[ ]	HRS:MINS
3: SET LOWER ALTITUDE LIMIT	______ XXX.X Km	ORBITER ALTITUDE	[ ]	Km
4: SET ALTITUDE RESOLUTION ΔZ	______ X.XX Km	ANGLE ORBITER +Z TO NADIR	[ ]	DEGREES
5: SPARE				
6: SPARE				
7: RAW COUNTS VS. ALTITUDE	______ I/D			
8: Na DENSITY VS. ALTITUDE	______ I/D			
9: DENSITY MINUS AVERAGE DENSITY	______ I/D			
10: DENSITY MINUS AVERAGE DENSITY VS.(POSITION) DISTANCE	______ I/D			
11: DENSITY MINUS AVERAGE DENSITY VS.(POSITION) DISTANCE & ALTITUDE	______ I/D			

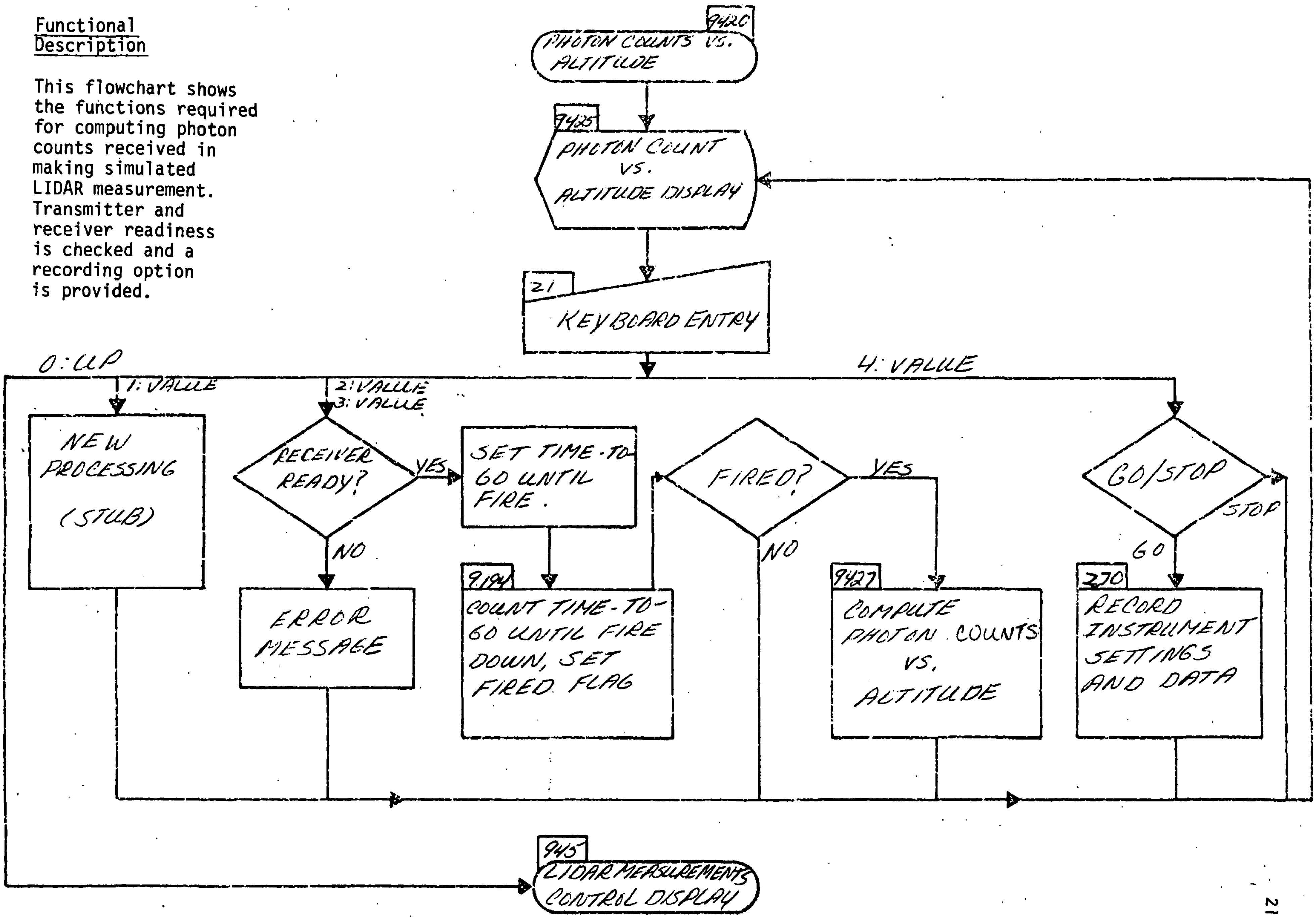
Functional Description

This flowchart shows the Night versus day computation that supports the computation of which are forbidden (day) times to gather the data of this experiment.



Functional
Description

This flowchart shows the functions required for computing photon counts received in making simulated LIDAR measurement. Transmitter and receiver readiness is checked and a recording option is provided.



9425 PHOTON COUNTS VERSUS
ALTITUDE DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO LIDAR MEASUREMENTS CONTROL DISPLAY

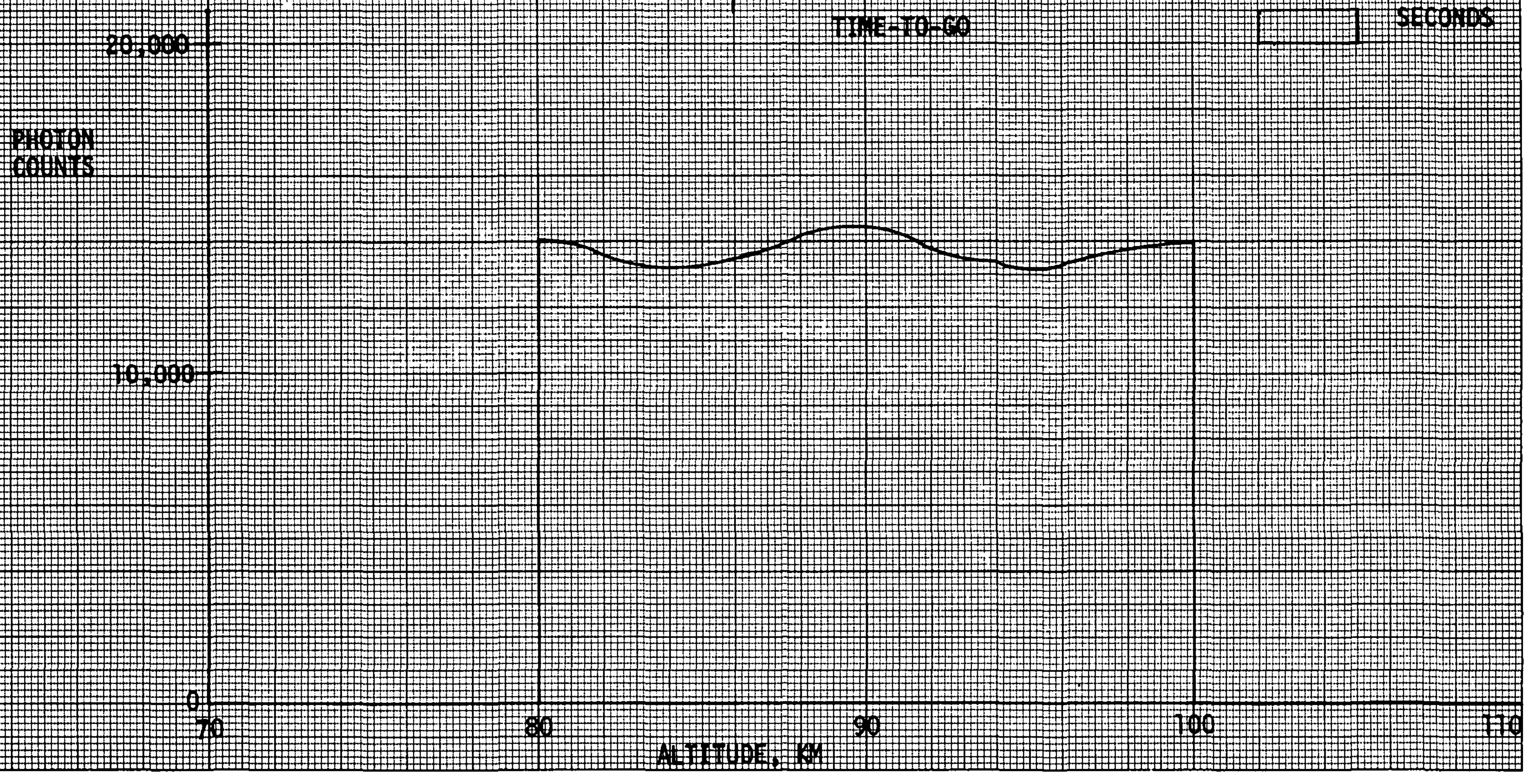
1: SPARE

2: LIDAR MEASUREMENTS ______ GO/STOP

3: SET LASER TIME-TO-GO UNTIL FIRE ______ XX SECONDS

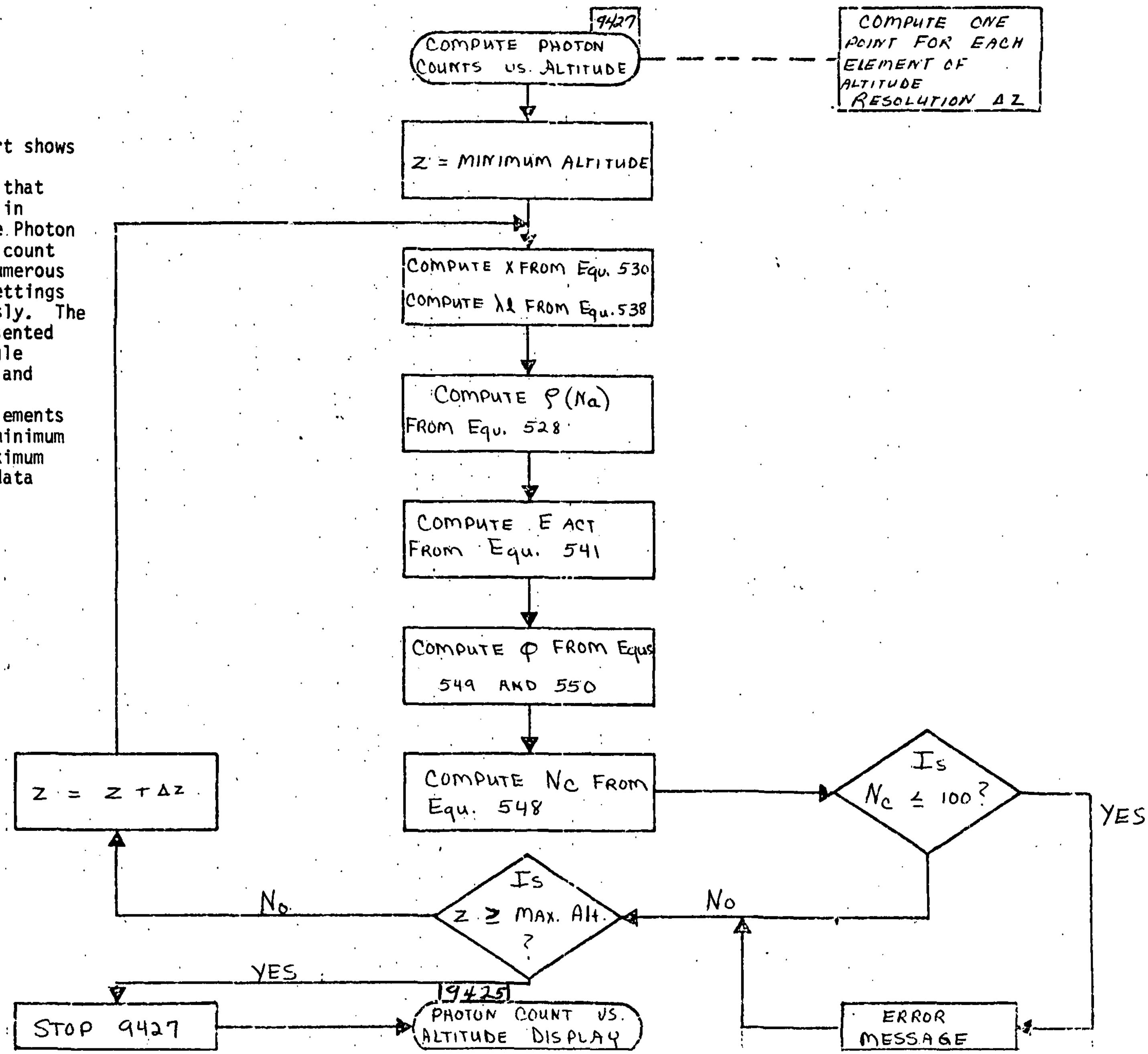
4: RECORD INSTRUMENT SETTINGS & DATA ______ GO/STOP

LATITUDE	[ ]	DEGREES
LONGITUDE	[ ]	DEGREES
LOCAL TIME	[ ]	HRS:MINS
ORBITER ALTITUDE	[ ]	KM
ANGLE ORBITER +Z TO NADIR	[ ]	DEGREES
TIME-TO-GO	[ ]	SECONDS



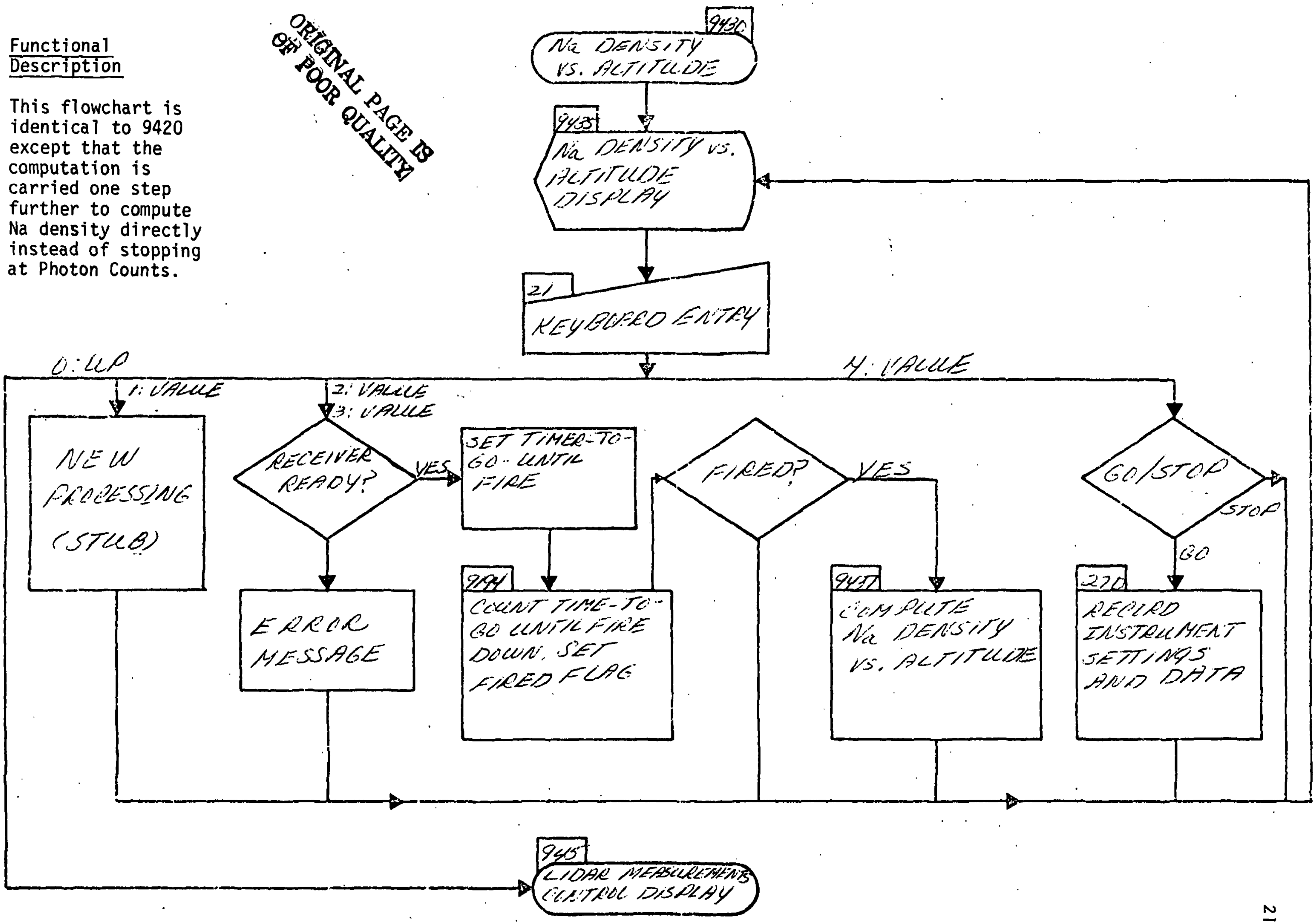
Functional Description

This flowchart shows the detailed computations that are involved in computing the Photon count. This count depends on numerous instrument settings made previously. The Count is presented due to a single Laser firing and presents all resolution elements ΔZ from the minimum up to the maximum altitude as data points.



Functional Description

This flowchart is identical to 9420 except that the computation is carried one step further to compute Na density directly instead of stopping at Photon Counts.



9435 Na DENSITY VERSUS ALTITUDE
DISPLAY

ERROR MSG:

0: PROCEDURE — UP/I/D
   UP TO LIDAR MEASUREMENTS CONTROL DISPLAY

1: SPARE

2: LIDAR MEASUREMENTS ______ GO/STOP

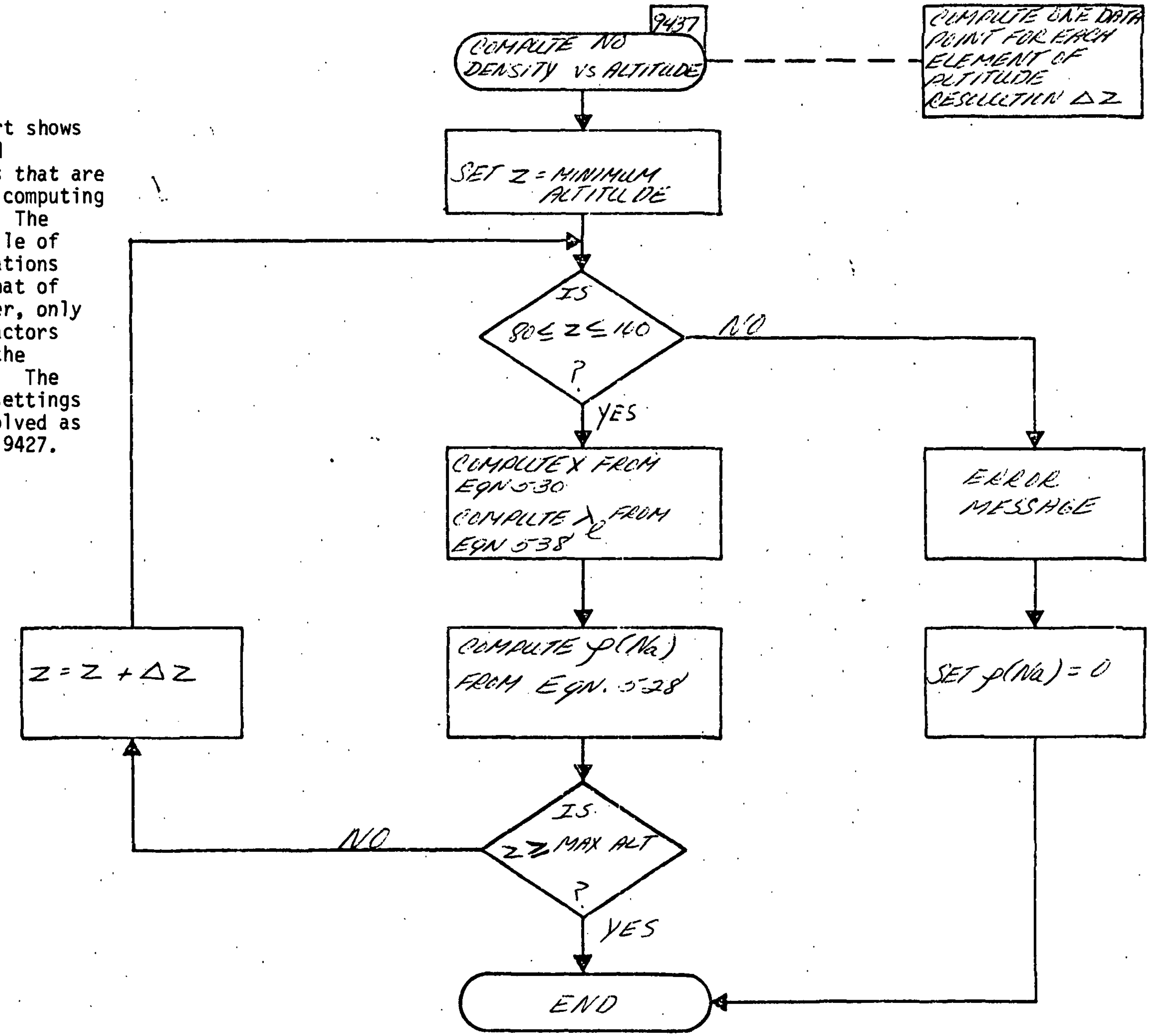
3: SET LASER TIME-TO-GO UNTIL FIRE ______ XX SECONDS

4: RECORD INSTRUMENT SETTINGS ______ GO/STOP
   AND DATA

LATITUDE	[ ]	DEGREES
LONGITUDE	[ ]	DEGREES
LOCAL TIME	[ ]	HRS:MINS
ORBITER ALTITUDE	[ ]	KM
ANGLE ORBITER +Z TO NADIR	[ ]	DEGREES
TIME-TO-GO	[ ]	SECONDS

Functional Description

The flowchart shows the detailed computations that are involved in computing Na Density. The output profile of this computations resembles that of 9427, however, only geometric factors enter into the computation. The instrument settings are not involved as they are in 9427.



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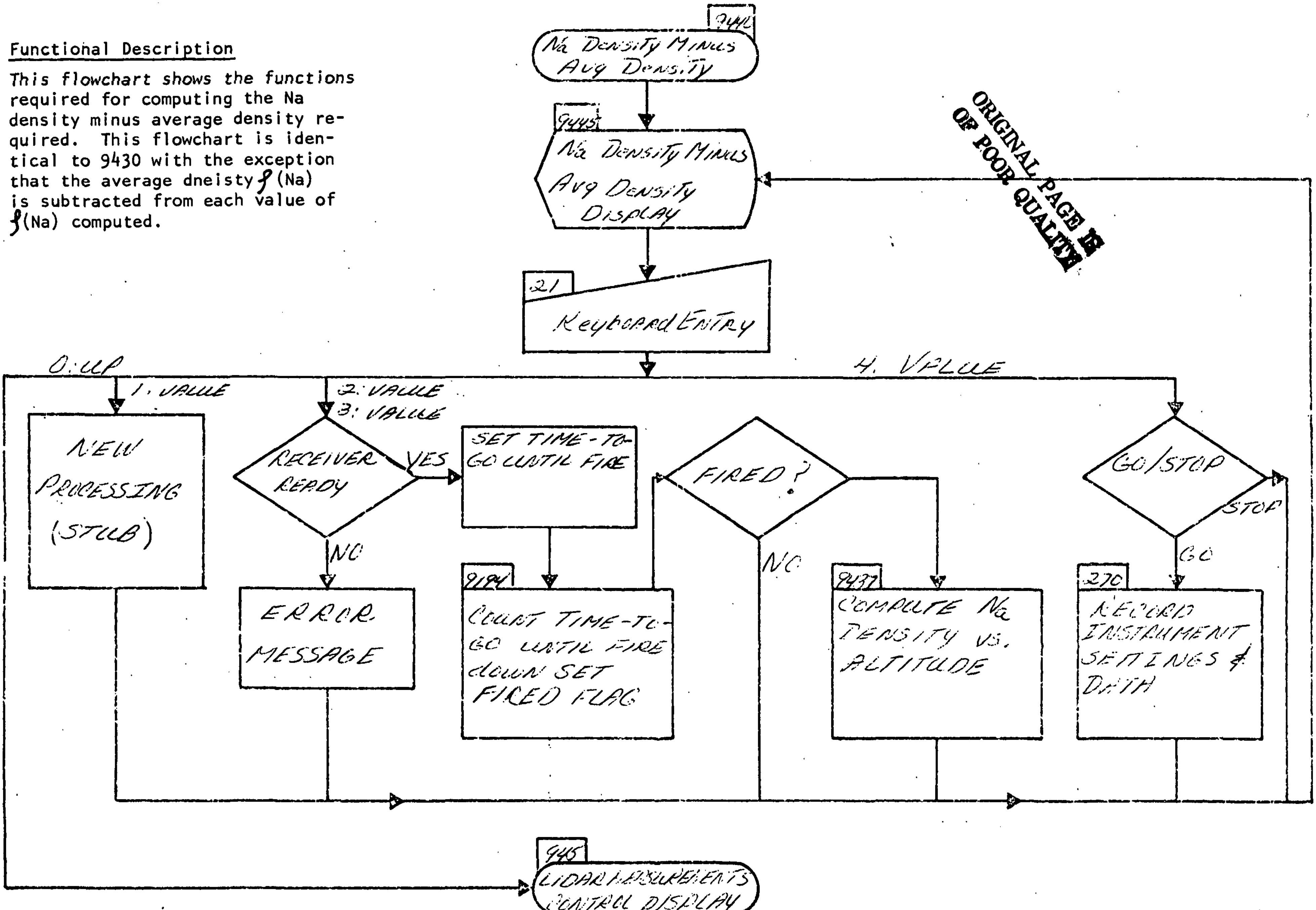
Functional Description

This flowchart shows the functions required for computing the Na density minus average density required. This flowchart is identical to 9430 with the exception that the average dneisty $\bar{\rho}$(Na) is subtracted from each value of ρ(Na) computed.



9445 Na DENSITY MINUS AVERAGE
DENSITY DISPLAY

ERROR MSG:

0: PROCEDURE UP/I/D
UP TO LIDAR MEASUREMENTS CONTROL DISPLAY

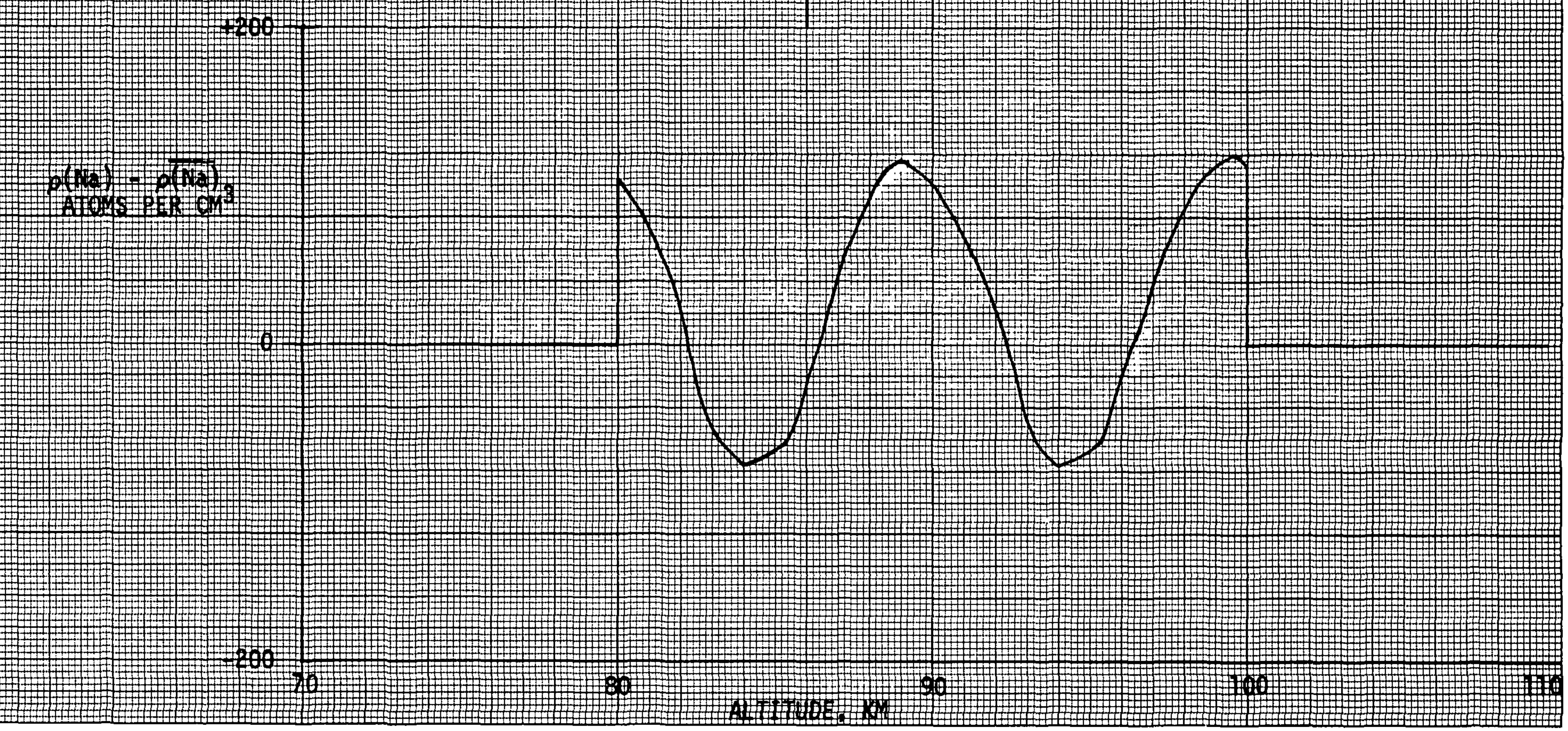
1: SPARE

2: LIDAR MEASUREMENTS ____ GO/STOP

3: SET LASER TIME-TO-GO UNTIL FIRE ____ XX SECONDS

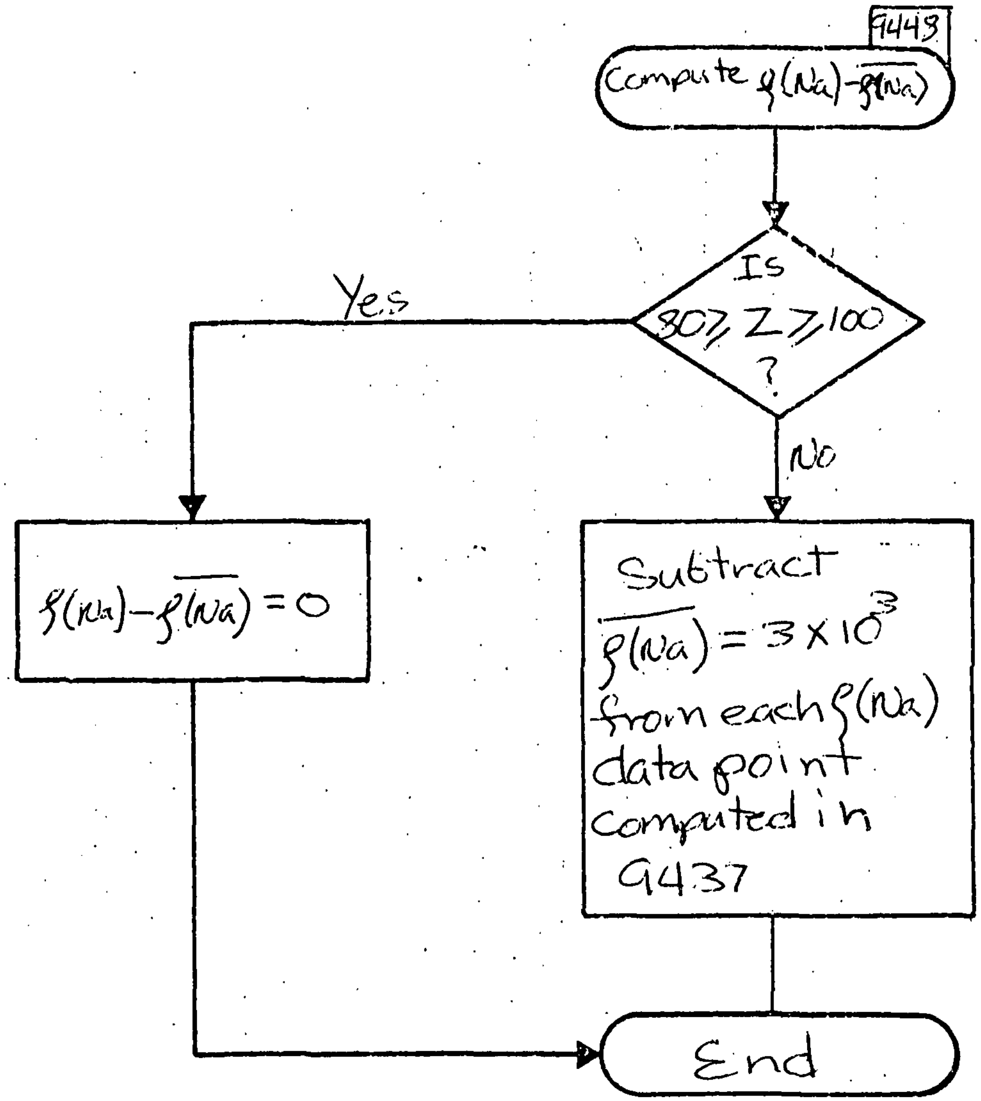
4: RECORD INSTRUMENT SETTINGS ____ GO/STOP
AND DATA

LATITUDE		DEGREES
LONGITUDE		DEGREES
LOCAL TIME		HRS:MINS
ORBITER ALTITUDE		KM
ANGLE ORBITER +Z TO NADIR		DEGREES
TIME-TO-GO		SECONDS



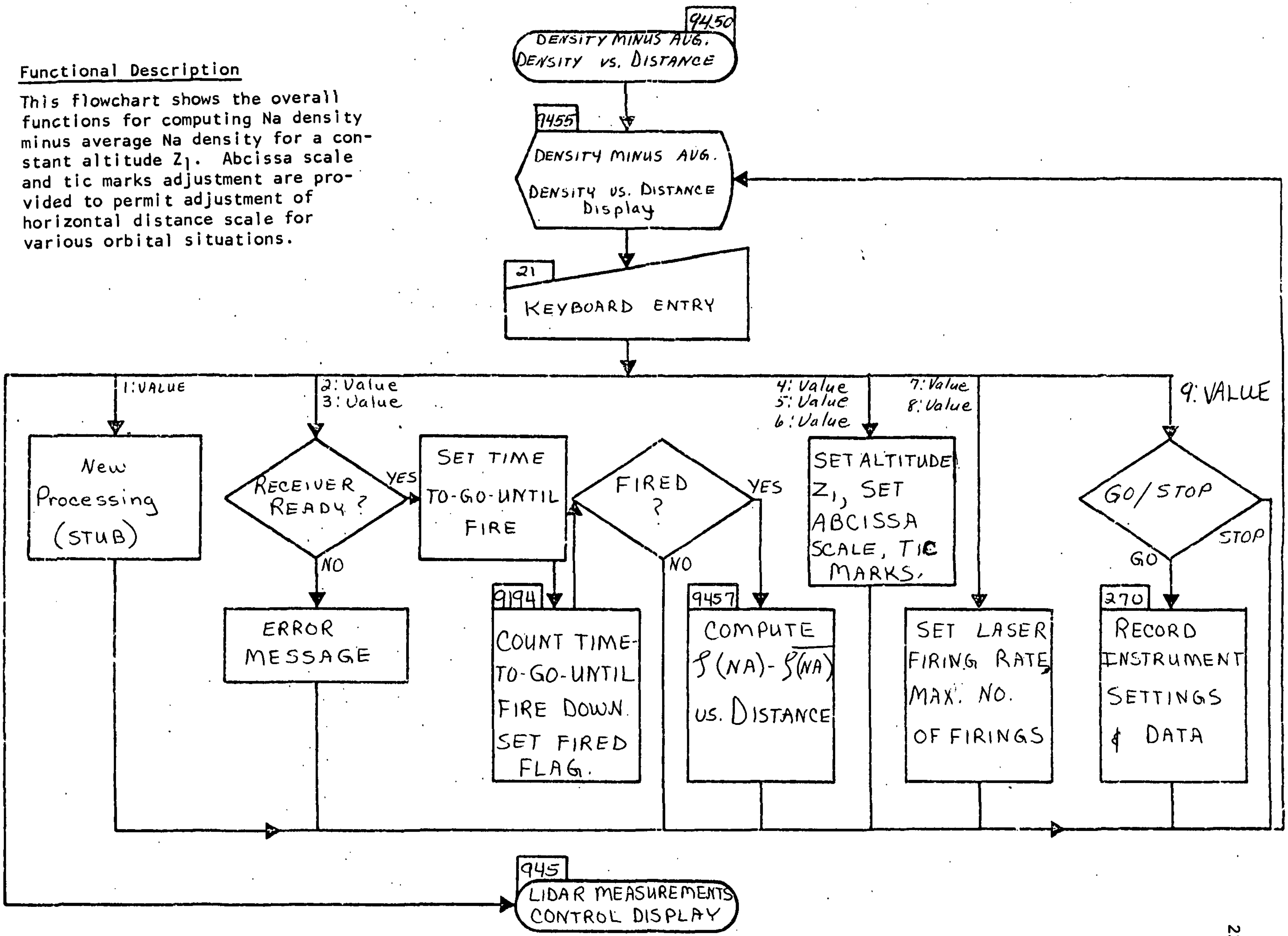
Functional Description

For each altitude increment ΔZ, this flowchart computes $\rho(na) - \rho(Na)$.



Functional Description

This flowchart shows the overall functions for computing Na density minus average Na density for a constant altitude Z_1. Abcissa scale and tic marks adjustment are provided to permit adjustment of horizontal distance scale for various orbital situations.



9455 DENSITY MINUS AVERAGE DENSITY
VERSUS DISTANCE DISPLAY

ERROR MSG:

0: PROCEDURE ______ UP/I/D
UP TO LIDAR MEASUREMENTS CONTROL DISPLAY

1: SPARE

2: LIDAR MEASUREMENTS ______ GO/STOP

3: SET LASER TIME-TO-GO UNTIL FIRE ______ XX SECONDS

4: SET ALTITUDE Z ______ XXX KM

5: SET ABCISSA SCALE ______ XX.X CM/KM

6: SET TIC MARKS EVERY ______ XX.X KM

7: FIRE LASER EVERY T_R ______ XX.X SECONDS

8: MAXIMUM NO. OF LASER FIRINGS ______ XXX
N MAX

9: RECORD INSTRUMENT SETTINGS & DATA ______ GO/STOP

LATITUDE ☐ DEGREES

LONGITUDE ☐ DEGREES

LOCAL TIME ☐ HRS:MINS

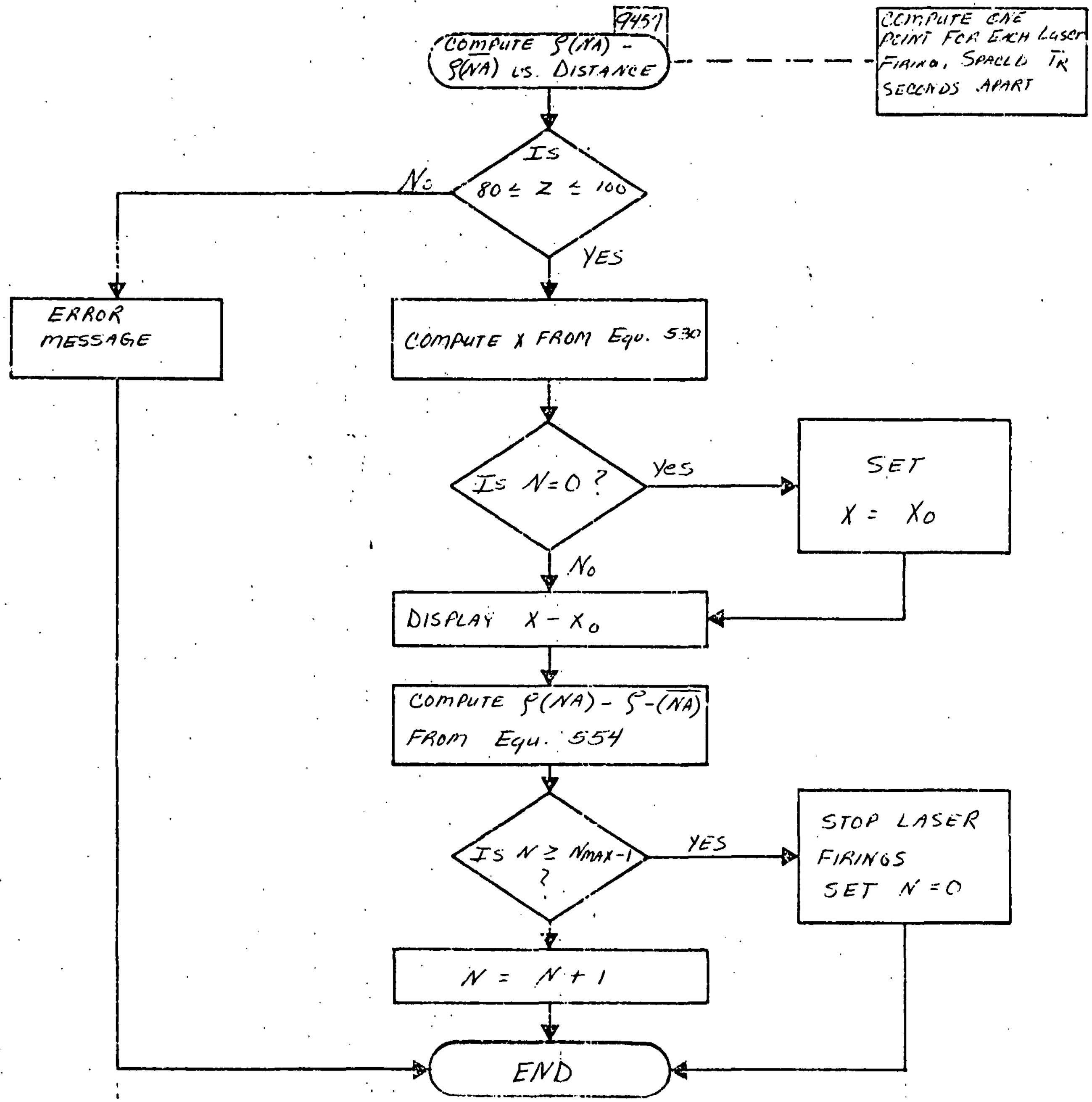
ORBITER ALTITUDE ☐ KM

TIME-TO-GO ☐ SECONDS

Functional Description

This flowchart computes $\rho(Na) - \bar{\rho}(Na)$.

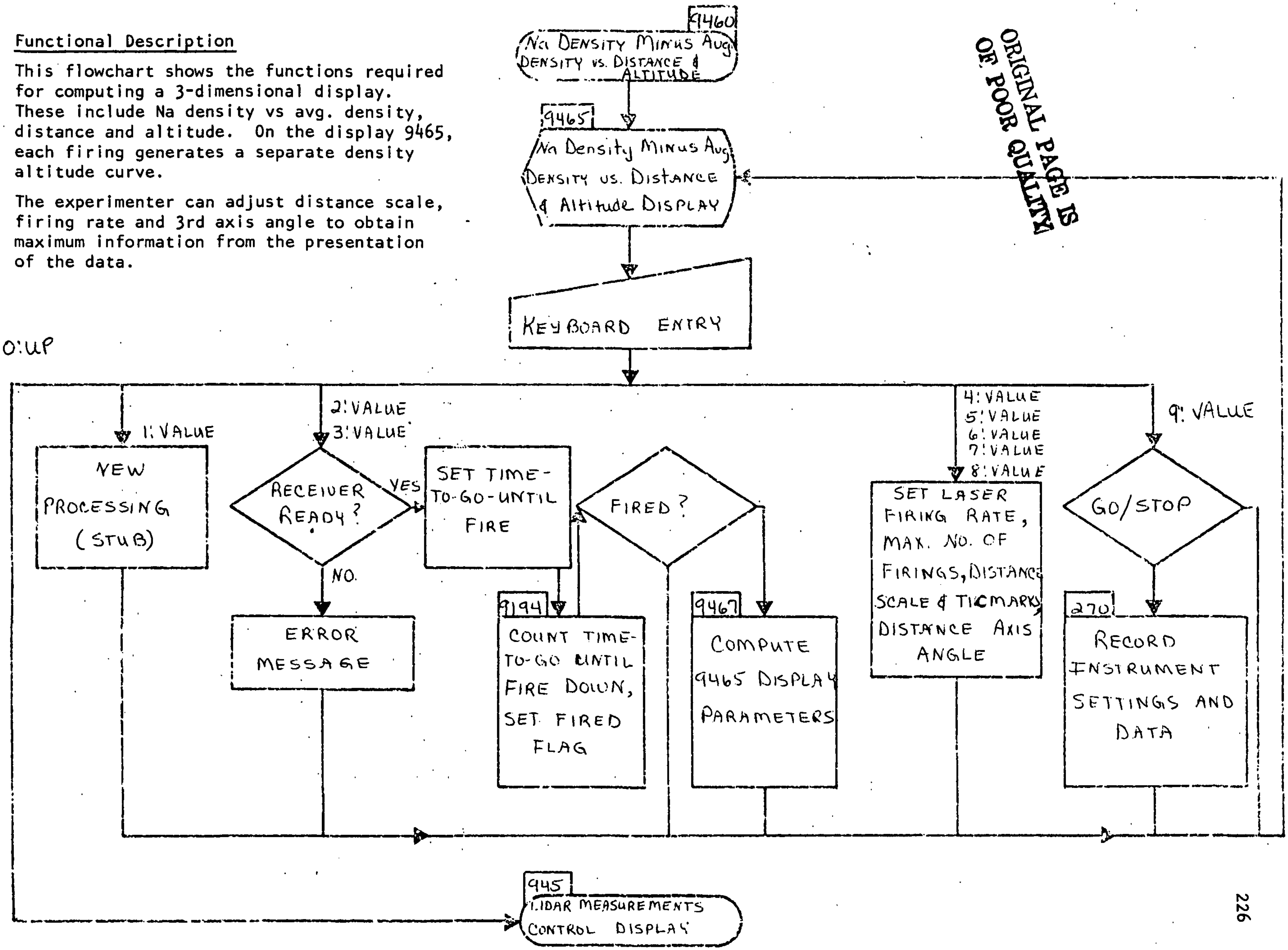
In order to start the abcissa x_0 of 9455 at zero kilometers distance, all subsequent iterations are displayed relative to x_0.



Functional Description

This flowchart shows the functions required for computing a 3-dimensional display. These include Na density vs avg. density, distance and altitude. On the display 9465, each firing generates a separate density altitude curve.

The experimenter can adjust distance scale, firing rate and 3rd axis angle to obtain maximum information from the presentation of the data.

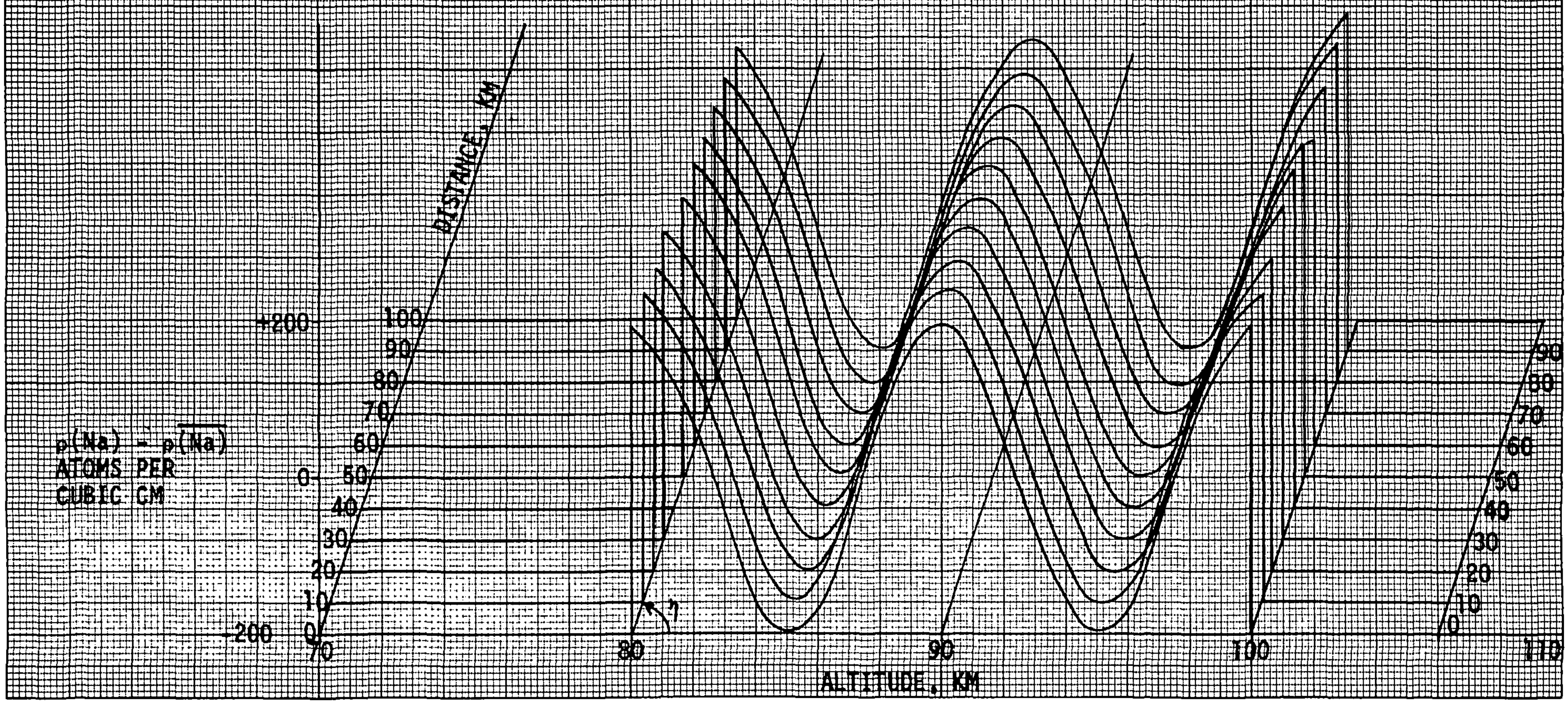


ERROR MSG:

9465 Na DENSITY MINUS AVG.
DENSITY VS. DISTANCE & ALTITUDE DISPLAY

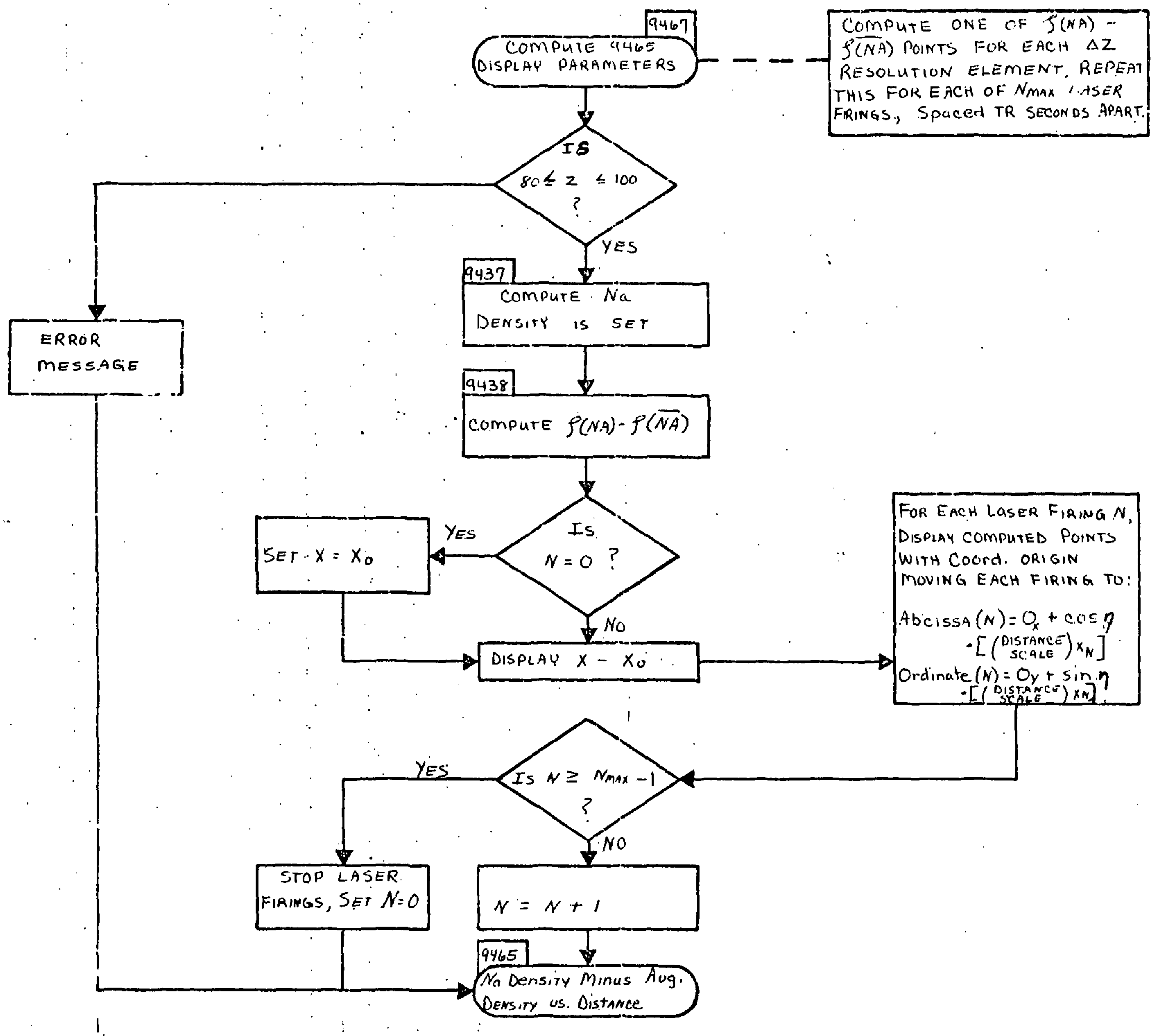
0: PROCEDURE ______ UP/I/D UP TO LIDAR MEASUREMENTS
CONTROL DISPLAY
1: SPARE
2: LIDAR MEASUREMENTS ______ GO/STOP
3: SET LASER TIME-TO-GO ______ XX SECONDS UNTIL FIRE
4: SET DISTANCE AXIS ANGLE η ______ XX DEGREES

5: LASER FIRES EVERY T_R ______ XX.XX SECONDS
6: MAXIMUM NUMBER OF FIRINGS ______ XX
N MAX
7: SET DISTANCE SCALE ______ XX.XX CM/KM
8: TIC MARK DISTANCE SCALE EVERY ______ X.X CM
9: RECORD INSTRUMENT SETTINGS ______ GO/STOP AND DATA



Functional Description

This flowchart shows the computation of the "3-dimensional" display parameters of 9465. The logic flow is a combination of the flows used for Density & Altitude and Density vs. Distance equations. For each laser firing N the origin of coordinates moves by an amount depending on the horizontal distance X_N travelled by the orbiter.



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6.6 ADDITIONAL FLOWCHARTS: CONVERSION OF UNITS AND CALIBRATION DATA

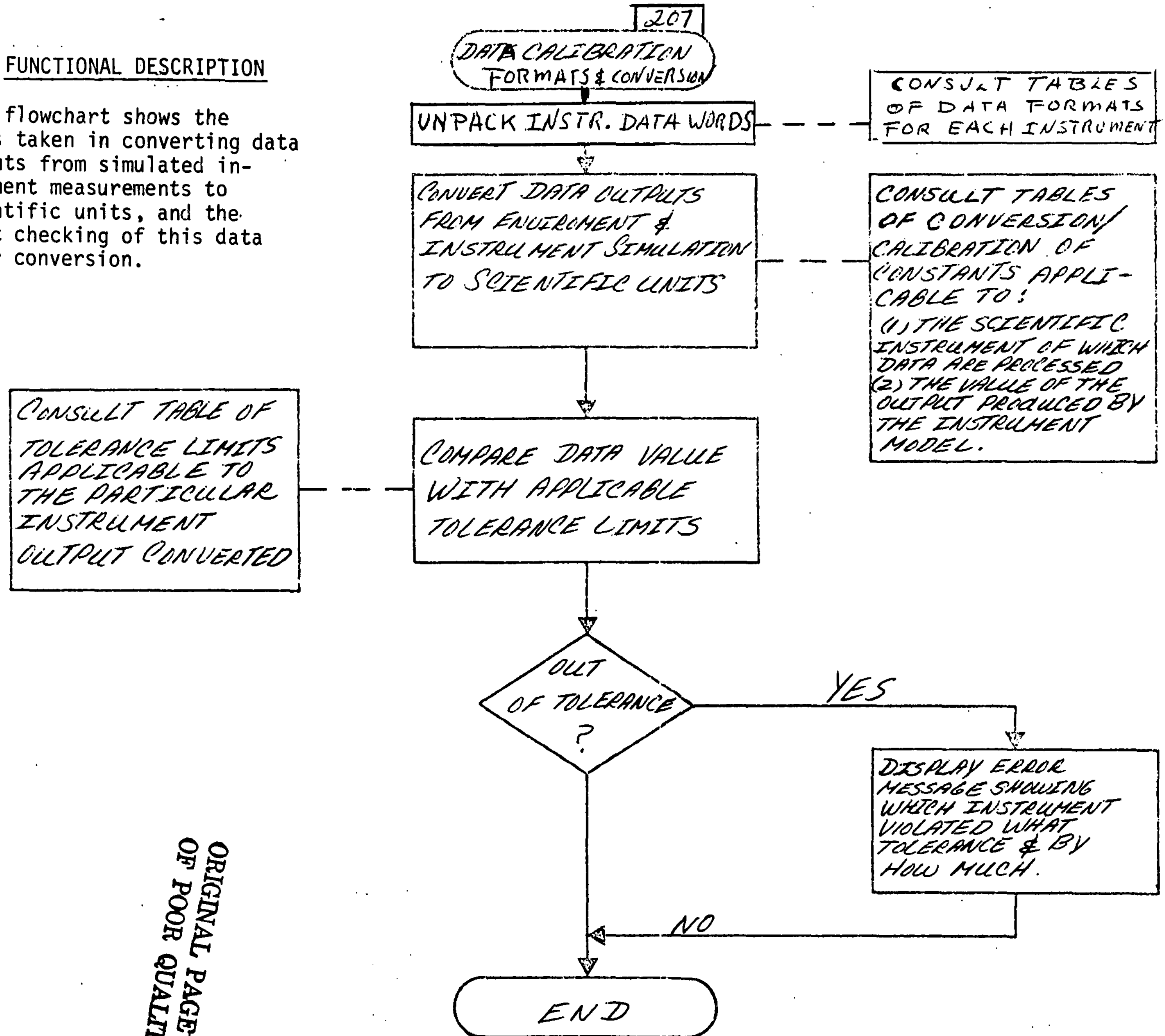
In the current conception of the CVT simulation, the simulation of the physical environment takes place directly in scientific units. These same scientific units are (in most cases) used for display and recording.

The attached flow charts supplement the above concept should the CVT simulation be extended to include hardware elements and special display and data recording format requirements.

Flowchart 207 unpacks data words, converts or calibrates data to scientific units and limit checks these. Flowcharts 208 and 209 convert the scientific data for display and for recording output formats, respectively, and limit checks these again to be sure that they will fit the output equipment.

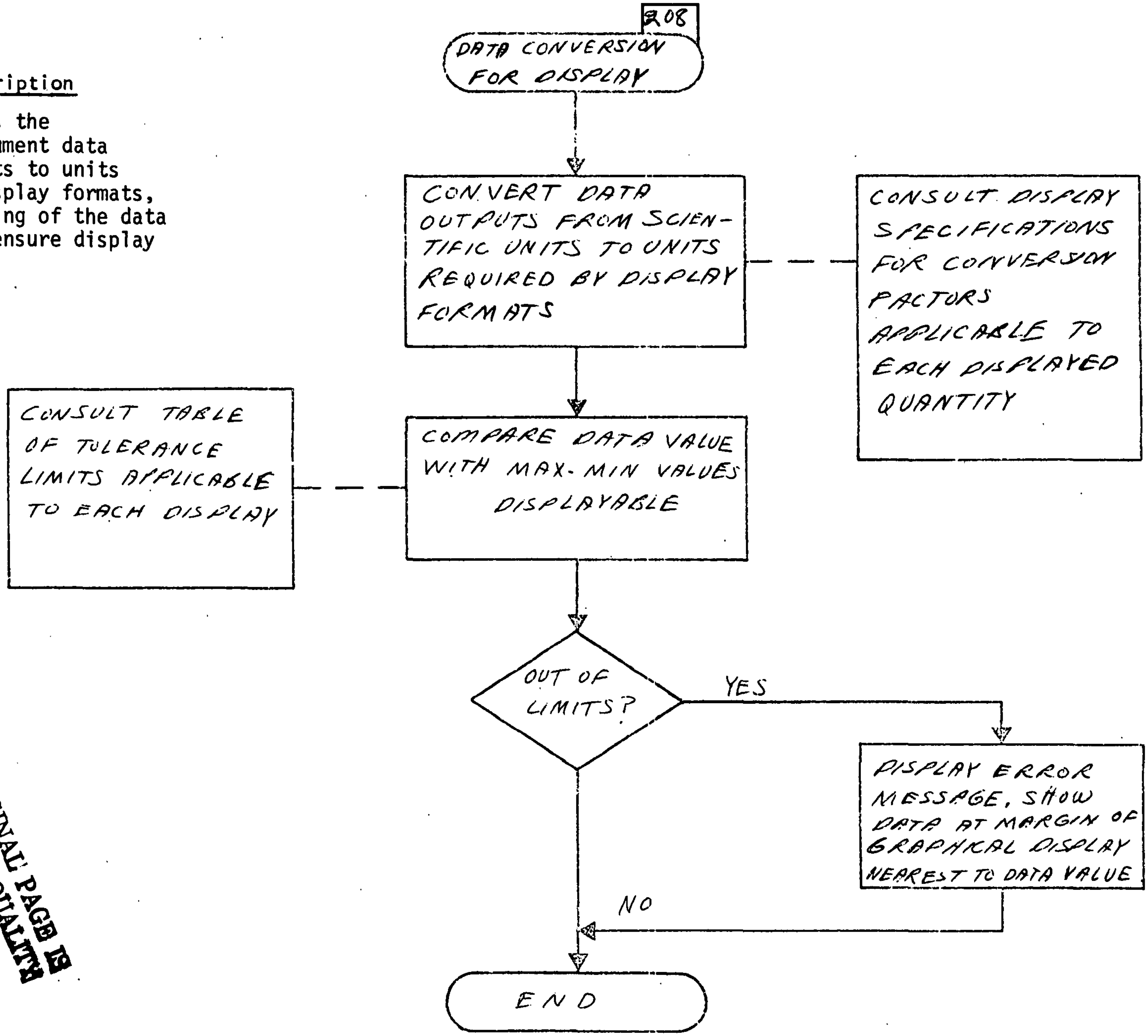
207 FUNCTIONAL DESCRIPTION

This flowchart shows the steps taken in converting data outputs from simulated instrument measurements to scientific units, and the limit checking of this data after conversion.



208 Functional Description

This flowchart shows the conversion of instrument data from scientific units to units specified by the display formats, and the limit checking of the data to be displayed to ensure display compatibility.



209 Functional Description

This flowchart shows the conversion of instrument data in scientific units to a format suitable for data recording. All data are limit checked to ensure that each data value is flagged as being in/out of tolerance.